In this Issue: Seepage Losses from Streams in Owens Valley, Cal.—A Two-Story Street Railway Terminal.—Typhoid Statistics in American Cities.—Low Cost Freight Transportation, Bessemer & Lake Erie R. R.

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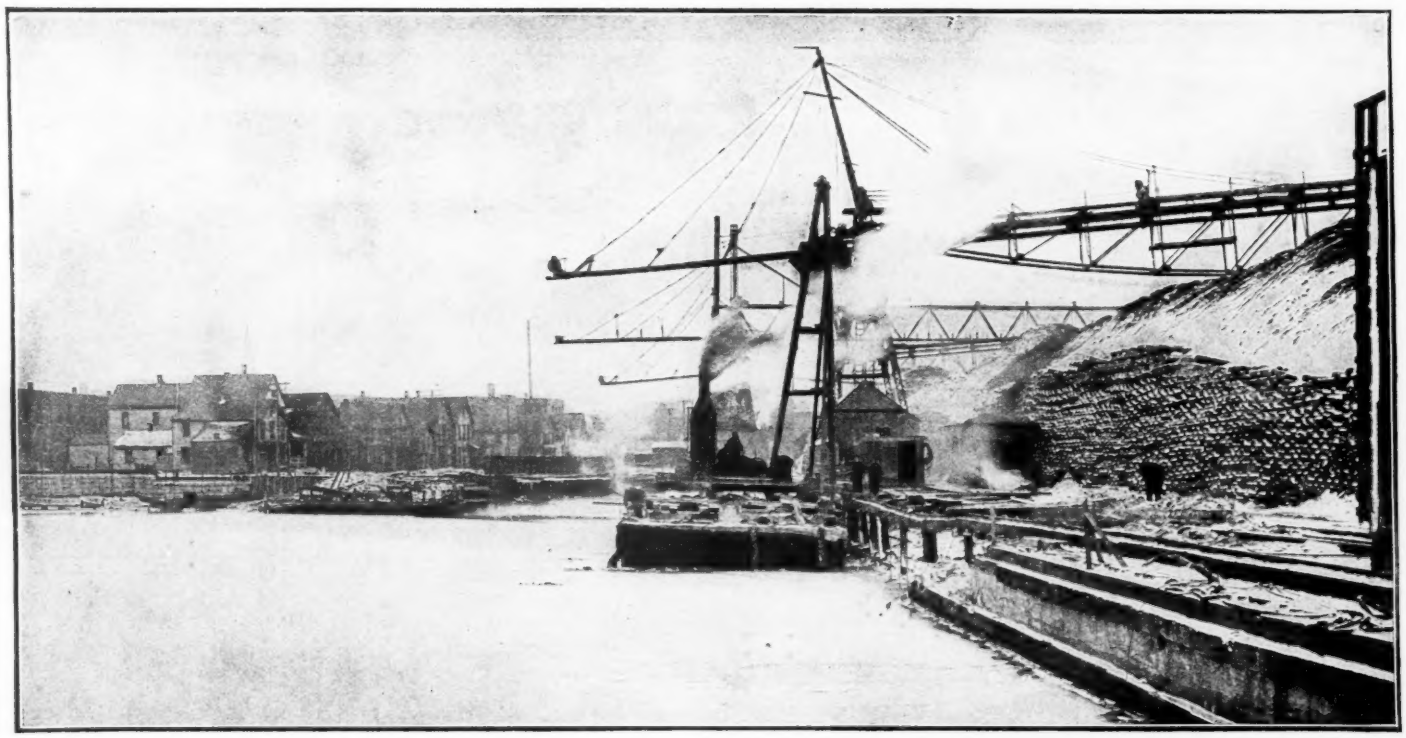

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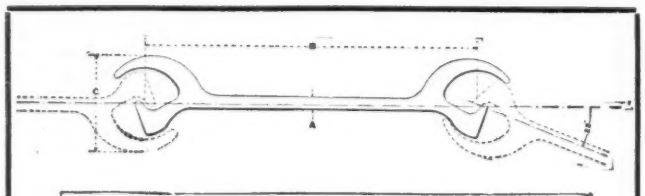

A		B		C
Thickness of Web	Weight per Square Foot of Wall	Distance Center to Center of Joints	Weight per Lineal Foot	Width of Joint Over All
½ inch	40.00 pounds	12¾ inches	42,500 pounds	3⅛ inches
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ENGINEERING NEWS

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A Study of Seepage Losses from Streams in Owens Valley, California.

By CHARLES H. LEE, Jun. Am. Soc. C. E.*

The water-supply investigations which are being carried on in Owens Valley, California, by the city of Los Angeles in connection with the building of the Los Angeles Aqueduct, have been planned along somewhat original lines and involve field studies of several subjects upon which the water-supply engineer of the West has very little data. One of these studies which has now covered a period sufficiently long to yield reliable results, is that of seepage losses from small mountain streams after they leave their canyons and flow out into the desert valleys typical of the arid West. The investigations are being carried on by the writer under the direction of Mr. William Mulholland, M. Am. Soc. C. E., Chief Engineer of the Los Angeles Aqueduct.

There are three factors governing the amount of seepage loss which may occur from a channel containing flowing water. Briefly stated they are as follows:

(1) The rate of percolation.

(2) The area through which percolation occurs. (The wetted perimeter.)

(3) The period of time during which a given unit of water is exposed.

The rate of percolation depends on, (1) the character of the channel lining and the medium surrounding the channel as regards size of pores and porosity; (2) the pressure gradient, depending on the difference in level of the surface of water in the channel and the ground-water surface; (3) the temperature of the water. The effects of these elements upon the rate of percolation are too obvious to need explanation, although the accompanying table, prepared by Prof. L. G. Carpenter [Fort Collins, Colo.] is instructive in showing the relation of temperature and seepage loss.

Relative flow of water through a porous medium at various temperatures, assuming the rate of flow at 32° F. as unity.*

Temperature, Deg. F.	Velocity.	Temperature, Deg. F.	Velocity.
32	1.000	72	1.860
42	1.195	82	2.109
52	1.403	92	2.372
62	1.624	102	2.649

*See Engineering News, June 30, 1898, page 422.

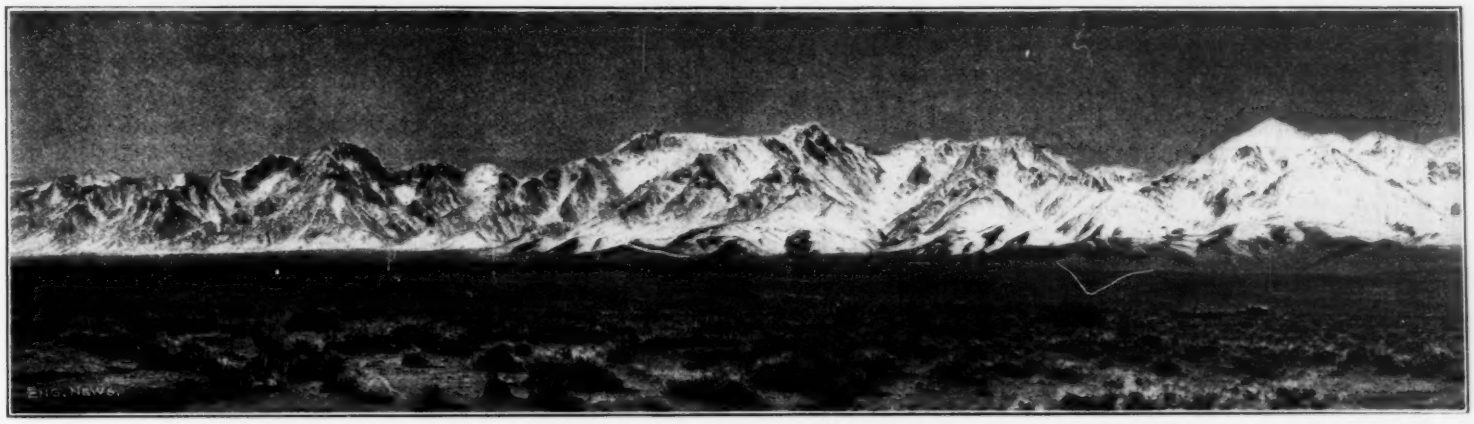
Other conditions being the same, the effect of an increase in the wetted perimeter is obviously to increase the seepage loss, but accompanying such change is a proportionally larger increase in the velocity of flow which reduces the time of exposure of a given volume of water. The net result, considering the total flow, is therefore a proportionally smaller loss, although this effect may be counteracted to a certain extent by the scouring out of a non-porous channel lining, due to the increased carrying power of the stream. The whole subject is dependent upon so many indeterminate conditions that a general mathematical analysis is impossible, and the best that can be done is to make a study covering the ordinary range of temperature and discharge for each section of channel under consideration.

The Owens Valley is a long narrow basin lying at the base of the steep eastern slope of the Sierra Nevada (see front page view) bordered on the east by the equally steep face of the White and Inyo Mountains. Generally speaking, it has been formed by the same processes that are responsible for the adjacent ranges, namely, great crustal movements of the earth's surface. The subsequent work of erosive agents has cut deep canyons in these mountains and carried the resulting waste into the valley, filling in its irregularities and building up in front of each canyon great piles of debris known as alluvial cones or fans. These fans reach their greatest development in the region ten miles north and south of the town of Independence, where they extend out into the valley from four to seven miles and at the apex have an elevation above the valley floor of about 2,000 ft. The streams which are the subject of this study are all located near Independence, and all data herewith presented apply to this region.

In general, the fragmental material found in these cones is granite with a slight mixture of altered slate which came in contact with the granite before the latter had cooled. The fragments are all more or less rounded by water erosion and vary in size from boulders containing more than 100 cu. yds. to fine sand and clay. The coarser material is found at the higher elevations, while the finer gravels, sands, and clays are spread out in well-defined layers toward the outer borders. During a period of volcanic activity along a line of weakness at the base of the Sierra, there were a number of small lava flows which spread out over the upper slopes of the cones and in some instances extended well out into the valley. Some of these have subsequently been covered with a thin sheet of alluvial material, but this is not sufficient to entirely insulate the lava as a carrying medium for seepage water.

The stream channels are rough and full of boulders, with many cascades, and their slopes are steep. At the point of leaving the mountains they occupy trenches cut into the apex of the cone to a depth of from 50 to 100 ft. These gradually become shallower in advancing down the cone, and at a distance of from one to three miles from the mountains the streams flow out onto the general surface. From here on they occupy shallow trenches from 10 to 20 ft. in depth to a point about half a mile from the valley floor, when they again flow out onto the surface. It is

*Assistant Engineer, Los Angeles Aqueduct, Independence, Cal.



SIERRA NEVADA MOUNTAINS FROM INDEPENDENCE, CAL.

(Showing mountain catchment areas and outwash slopes. The elevation of the crest of the mountain is about 13,000 ft.; the base is about 6,200 ft.; and the picture was taken from an elevation of 4,000 ft. The base of the mountain is six miles away at the nearest point. The line of pine and birch trees in the center of the picture mark the channel of the stream draining the deep canyon on the right.)

here that irrigation diversions are made and just above the division boxes are the gaging stations maintained by the U. S. Geological Survey. East of here a distance of from half a mile to a mile are meadows and numerous springs indicating the level of ground water, but at no point above the Government stations is the depth to general ground-water level less than 50 ft.

The slopes of these stream channels vary from 500 to 600 ft. per mile in their upper portions to 300 ft. per mile near the valley. A test made with aniline dye over a typical section of channel 2.3 miles in length indicated a mean velocity head of 1.06 mi. per hr. (1.55 ft. per sec.). The mean velocity in gaging sections is ordinarily greater than this, but in a stretch of channel considerable time is lost in passing around obstacles and also at cascades and in pools.

The water is always clear. In the high-water season there is considerable coarse material carried along the bottom of the channel, but the absence of fine sand and silt is conspicuous. This condition is very important in the study of seepage losses, for a muddy stream tends to seal up the pores in the channel lining and reduce the rate of percolation.

Although the surrounding country is bare of vegetation, except for stunted desert shrubs, there is a narrow fringe of birch and cottonwood trees on either bank, which in many places reaches over the stream, completely shielding it from sun and wind.

The water appearing in the streams under consideration is derived entirely from precipitation within the mountain canyons, and in general no increment in flow occurs below the canyon mouth. Precipitation is almost entirely in the form of snow, and 80% of it occurs during the months November to March, inclusive. Expressed as equivalent water it varies from about 30 ins. per annum at the Sierra crest to 15 ins. at the mouth of canyon. The average run-off is probably about 80% of the precipitation, and for the drainage basins considered ranges from 1.75 to 1.25 sec.-ft. per sq. mi., depending on the precipitation and the exposure. The effective drainage areas range from 4.5 sq. mi. to 12 sq. mi. The flow is quite uniform from September to April, inclusive, with minimum values from December to March. In most of the streams, 70% of the run-off occurs from May to August, inclusive. In a few, as Taboose Creek, where glacial deposits and slide accumulations choke the middle and upper portions of the canyons, there is a marked regulating effect by ground storage, and 55% of the run-off occurs during these months. Maximum run-offs occur from June 15 to July 15, and are from 10 to 25 times the minimum, depending on the effectiveness of ground storage in the catchment basin.

The temperature (Fahrenheit scale) of water as it issues from the canyons varies from 35° to 42° in winter and from 48° to 53° in summer. In winter it does not increase much in traveling toward the valley, and in December and January actually becomes colder after leaving the protecting cover of the snow in the canyons, and ice conditions prevail for several weeks. In summer there is an increase of about 10° between the mouth of the canyon and the U. S. Geological Survey stations. Average monthly air tempera

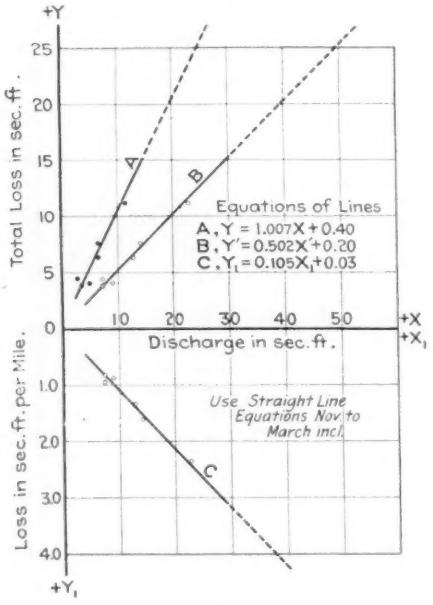

+Y
Total Loss in sec. ft.
Equations of Lines
A, Y = 1.007X + 0.40
B, Y' = 0.502X' + 0.20
C, Y₁ = 0.105X₁ + 0.03
Discharge in sec. ft.
+X
+X₁
Use Straight Line Equations Nov. to March incl.
Loss in sec. ft. per Mile.
+Y₁

Fig. 1. Taboose Creek.
Channel length, 4.8 miles.

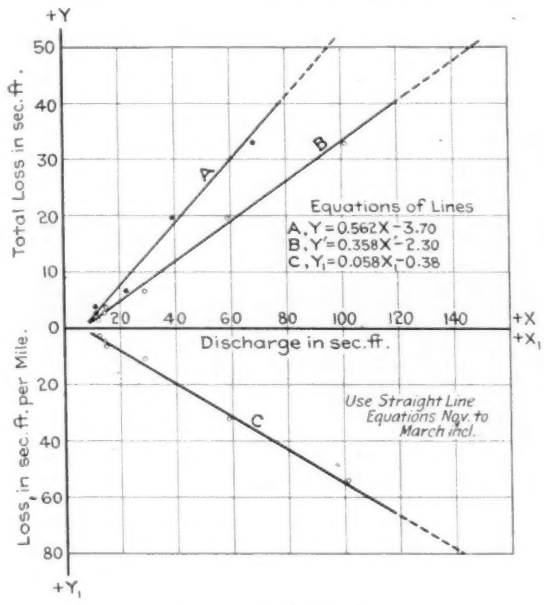

+Y
Total Loss in sec. ft.
Equations of Lines
A, Y = 0.562X − 3.70
B, Y' = 0.358X' − 2.30
C, Y₁ = 0.058X₁ − 0.38
Discharge in sec. ft.
+X
+X₁
Use Straight Line Equations Nov. to March incl.
Loss in sec. ft. per Mile.
+Y₁

Fig. 2. Oak Creek.
Combined channel length, 6.1 miles.

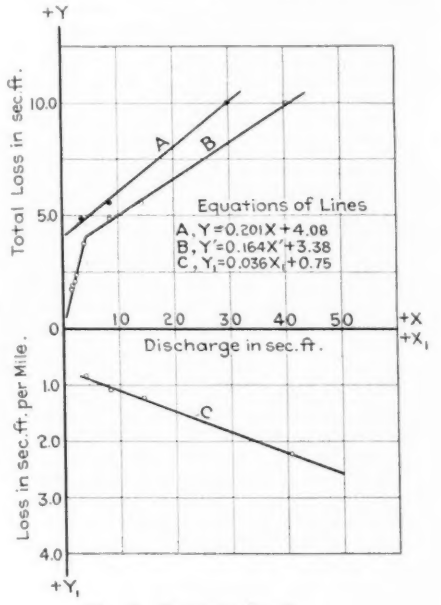


Fig. 3. Symmes Creek.
Channel length, 4.5 miles.

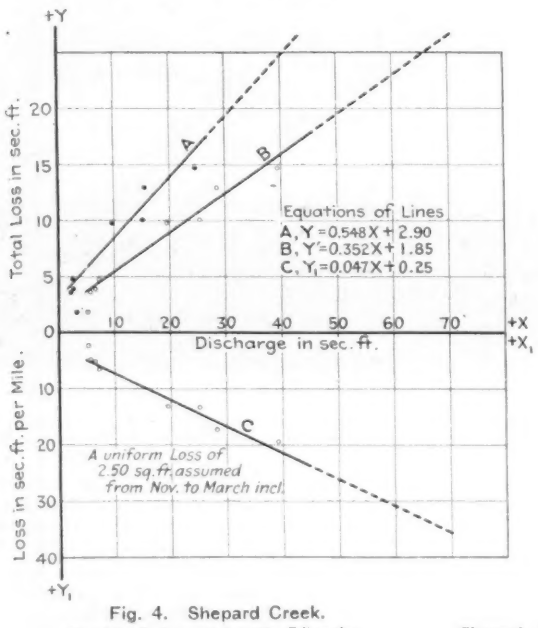

+Y
Total Loss in sec. ft.
Equations of Lines
A, Y = 0.548X + 2.90
B, Y' = 0.352X + 1.85
C, Y₁ = 0.047X + 0.25
Discharge in sec. ft.
+X
+X₁
A uniform Loss of 2.50 sq. ft. assumed from Nov. to March incl.
Loss in sec. ft. per Mile.
+Y₁

Fig. 4. Shepard Creek.
Combined channel length, 7.5 miles.

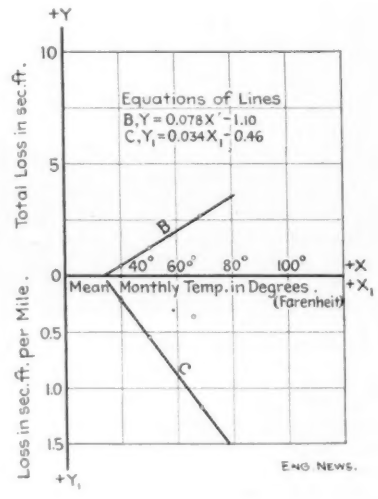


Fig. 5. Division Creek.
Channel length, 2.3 miles. Temperatures are means of 30 days preceding dates of measurement.

FIGS. 1 TO 5.
SEEPAGE LOSS DIAGRAMS FOR OUTWASH SLOPE CHANNELS OF STREAMS DRAINING HIGH MOUNTAIN AREAS IN THE VICINITY OF INDEPENDENCE, CAL.

tures at Independence range from 40.5° in January to 78.6° in July, with a mean annual of 58.2°. The average monthly air temperature is below 50° from November to March. During these five months, therefore, the soil near the surface is almost at the same temperature as the stream water, while during the remainder of the year it is warmer.

The general plan of field work was to make comparative current-meter measurements at the upper and lower ends of the selected channel sections, giving proper allowance of time for the passage of the water between the two stations, and repeating measurements at intervals of from six weeks to two months. The period of time covered by the measurements was from June 15, 1908, to Sept. 15, 1909, including the high-water period of both a dry and a wet year.

Discharge measurements were made with a small Price current meter. As far as possible each pair of measurements was made by the same observer with the same meter. Permanent gaging stations were established at the upper end of the selected channel sections, and the U. S. Geological Survey stations were used at the lower end. Although it is difficult to do very accurate meter work in this type of stream in high stages, it is believed that on the whole the results are reliable.

In general, the following deductions can be made after careful study of all the data gathered.

(1) There is a seepage loss from all the channels studied, varying in amount with the time of year and with different channel conditions. The range of values observed was from no loss to a maximum of 5.3 sec.-ft. per mi.

(2) Variation with the time of year is due to the combined effects of temperature, area of wetted perimeter, and velocity of flow, which all work more or less in harmony during the months April to October, inclusive. The resultant effect during these months can be expressed graphically by a straight line where losses are platted as abscissae and stream discharges as ordinates.

During the months November to March, the discharge remains practically constant and variations in losses are largely controlled by temperature. The total losses during this period are so small, however, that they can be determined for all practical uses without a detailed knowledge of their variation, and therefore no such study was made.

An interesting exception to these general statements should be noted in case of Division Creek, which had a practically uniform flow during most of the period of study. There is here a straight-line relation between loss and mean air temperature at Independence for the 30 days preceding the date of measurement.

(3) Variations under different channel conditions were most noticeable as regards the character of the surrounding medium. The loss from a channel crossing fissured lava, even when the latter was covered by a thin sheet of alluvium, was 30% greater than that in coarse alluvium. Many other conditions are probably effective, but this is the only one noted from these studies. No detailed study was made of the effect of varying conditions in various parts of the channels considered.

(4) Evaporation losses from the streams under consideration never exceed 2% of the flow even for short periods, and, in general, are less than 1%.

There were 13 streams included in the original study, but five of these illustrate the conclusions and graphical studies for them are shown in the accompanying diagrams. The streams are described as follows:

(1) Taboose Creek has a channel length of 4.8 miles, the first two miles of which are in coarse alluvial material, and the remainder in fissured lava with a thin covering of alluvium. The average slope is 367 ft. per mi. There is a luxuriant tree growth. The flow is somewhat uniform.

(2) Oak Creek has two forks leaving the mountains which join before reaching the valley. They are entirely in coarse alluvium and have a good tree growth. The length of the channels are: North Fork, 2.6 miles; South Fork, 3 miles, and below the junction .5-mile. The slope of the forks is 480 ft. per mi., and of the main channel 300 ft. per mi.

(3) Symmes Creek has a length of channel of 4.5 miles, entirely in coarse alluvial material and without any vegetation. The average slope is 400 ft. per mi. During seven months of the year the flow does not reach the valley.

(4) Shepard Creek branches 4.75 miles from the mouth of canyon. The North Branch has a channel length of 1.50 miles, and the South Branch 1.25 miles. The channel is in coarse alluvial material, and there is little vegetation. The average slope is 400 ft. per mi.

(5) Division Creek has a channel length of 2.3 miles in fissured lava with a thin alluvial covering, and has a luxuriant tree growth. The average slope is 687 ft. per mi. The flow was remarkably uniform during the period covered by the study, varying not more than 10% from the mean at any time during the period May 1, 1908, to April 30, 1909.

The diagrams were prepared for the purpose of computing discharges at the mouth of canyon from measurements at the U. S. Geological Survey gaging stations, and for the purpose of convenience include both the lines of total loss and loss per mile. The lines marked "A" express the relation of total loss to discharge at the U. S. Geological Survey gaging station; the lines marked "B" the relation of total loss to discharge at mouth of canyon; and the lines marked "C" the relation of loss per mile to the discharge at mouth of canyon. The diagrams are so arranged that by entering the discharge in second-feet at the U. S. Geological Survey station on the X-axis it is possible to read in succession, the total loss in sec.-ft., the discharge in sec.-ft. at mouth of canyon; and the loss in sec.-ft. per mile.

For obvious reasons the three lines will intersect at a point on the X-axis. This point lies to the left or right of the origin or coincides with it, depending on the loss at low-water stages during the months April to October, inclusive. Measurements made from November to March are given very little weight in fixing the positions of the lines. In the case of Symmes Creek the "A" line reaches the Y-axis because the stream is dry at the U. S. Geological Survey station during a part of the year.

In the diagram for Division Creek, the "B" line expresses the relation of total loss to temperature and the "C" line that of loss per mile to temperature. It is of interest to note that they intersect the X-axis at about 34°.

The practical result of these studies shows that estimates of total flow of mountain streams in Owens Valley near Independence, based on measurements just above irrigation diversions, represent in a normal season but 65% of the total yield of the catchment basins of these streams. There are additional losses by seepage below diversion, which probably would reduce the available surface flow at the upper edge of the valley floor to 50% of the total yield.

The conditions in Owens Valley are identical with those in many parts of the arid West, and these conclusions probably apply to the surface water-supplies of numerous agricultural districts as well as towns and cities throughout this region.

A Classification and Study of the Typhoid Statistics of the Cities of the United States.

By GEORGE RODNEY TAYLOR.*

The accompanying tables were originally prepared in a less extensive form for the purpose of showing how Scranton, Pa., compares with other American cities in its mortality from typhoid fever. With the thought that they might prove generally useful the writer has extended the figures and added some interpretative comment.

The cities used are those classed as Registration Cities by the U. S. Census Bureau and the rates are taken from their publications. For the registration cities of 25,000 and upward the publication of the rates was begun in 1898 while the rates for the cities between 8,000 and 25,000 were first published in 1900. In 1905 the Iowa cities were dropped from the registration lists; in 1906 a large number of cities were added, and in 1908 a further addition was made. These latter are not included in the table. In order to make the list more complete the death rates of the small registration cities of Massachusetts, Connecticut and New York, which were not published for the years 1898-99, were taken from the State Reports. Comparison of the State figures with the Census figures for the years 1900-07, when both are available, shows a reasonable agreement. Besides these the non-registration cities of Akron, Conneaut, and Lorain, Ohio, are included in Table I. for the entire period; while York, Pa., was non-registration during 1898-1905. The four cities last mentioned are not included in Table II.

A study of Table I. shows that American cities cannot yet expect typhoid death rates below 10 per 100,000 for any length of time. The cities whose rates are under 10 are all of less than 25,000 population, and half of them are shown for four years or less. Four of the remainder are Massachusetts suburban towns, two of them being residential suburbs of Boston. It is noteworthy that 3 of the 13 anthracite mining towns of Pennsylvania are in this group. The rates in the column of highest death rate exclude water-borne typhoid from this group. Of the cities of over 500,000 population, New York appears to have first chance of reaching this position, as the following figures show.

	Average rate. 1898-1902.	Average rate. 1904-08.
New York	19.7	15.6
Chicago	31.7	17.6
Boston	24.8	20.4
St. Louis	28.4	22.4
Baltimore	35.0	36.0
Philadelphia	47.9	56.2

Chicago's water-supply has been too uncertain in the past to venture predictions and the same is true of St. Louis, while Baltimore and Philadelphia are out of the question. New York should have a rate averaging ten for the period 1915-1920 if the present rate of decrease is maintained. Boston cannot reach this figure until after 1925, even at the present rate of decrease, and probably not even then if forced again to draw heavily on the Sudbury water-supply.

The grouping with rates between 10 and 20 per 100,000 should include the great majority of the northern cities. The fact that it does not contain any city of Indiana, Illinois, Iowa and Washington, only one city (9,000 population) in Ohio, and only a small percentage of the urban population of California, Michigan and Pennsylvania is due to polluted water-supplies.

The cities in this group may be divided into two classes: first, those in which the maximum rate is low, and second, the cities having a year or two of high rates counterbalanced by several years of very low rates. Yonkers, Cambridge, Rochester and New York are in the low class; while St. Joseph, Worcester, Fall River, St. Paul, Bridgeport, Jersey City, Newark, Syracuse, Utica, Providence, Milwaukee and Lowell belong in the high class.

Lowell's highest rate is in 1903, caused by the accidental introduction of polluted Merrimac River water into the mains for a few hours, following a fire. Jersey City and Newark have their highest rates in 1898 and 1899, respectively, when polluted Passaic River water was pumped as an emergency to meet a shortage in supply. (Whipple, "Typhoid Fever.") It is very probable that accidents and emergencies of this sort would furnish a reason for many of the high rates in this group. In at least one of the towns (Plymouth, Mass.) the high rate of 55.0 in 1904 is due to a milk epidemic. (U. S. Public-Health and Marine Hospital Bulletin, No. 41.)

In the group between 20 and 30 the majority of cities show typhoid outbreaks, some of them severe, as Framingham, Mass., and Newport, R. I. Other cities, as Boston, show moderately high rates for a number of years, pointing to slight but persistent infection of supplies, probably water.

Going up the groups we find the amount of water in infection increasing markedly. Several towns are to be noted with normally low rates whose averages are raised by one year of water-borne infection. Examples of these are Peekskill, N. Y., with its 1908 rate of 201.3 and average of 38.7; Mankato, Minn., with the 1908 rate of 276.0 and average of 47.6; Ithaca, N. Y., with the 1903 rate of 336.9 and average of 47.2, and South Bethlehem, Pa., with its 1903 rate of 205.3 and average of 51.0. In the group between 50 and 60 are a number of cities showing continuous water-borne typhoid, as Philadelphia and Norristown, Pa., Watervliet, N. Y., Duluth, Minn. In the higher groups we have McKeesport, Pa., Hammond, Ind., Pittsburg, Niagara Falls, with its lowest rate in 11 years of 98.0, and Sharon, Pa., with its lowest rate in three years of 109.2.

All that has been said above relates to northern cities alone. The typhoid rates of the southern cities range from Galveston, Tex., with an average rate of 34, to Jacksonville, Fla., with an average of 88.1. Memphis and New Orleans with rates of 38.7 and 43.7 follow Galveston. Only two southern cities have their lowest rates below 25, Key West with 10.4 and Savannah with 22.5.

Four other southern cities have their lowest rates below 30, four between 30 and 40, while the remaining seven have their minimum rate above 40. The cities of the border states of Maryland, Delaware, West Virginia, Kentucky, and Missouri range from St. Joseph, Mo., with

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its average of 13.4, to Cumberland, Md., with an average of 115.8.

That some of the typhoid deaths of the southern cities is due to polluted water is unquestionable, but the experience of Washington, D. C., proves that there is a larger amount of typhoid fever left after the removal of known sources of infection than is true in the north.

A study of the rural and urban typhoid fever rates of the registration states gives further light on the question. The following rates are taken from the United States Mortality Reports.

State.	Urban rate.	Rural rate.	Years.
Rhode Island	18.7	19.3	1900-07
New Hampshire	18.8	18.7	1900-07
Massachusetts	18.9	13.9	1900-07
New Jersey	21.0	16.6	1900-07
New York	21.9	22.1	1900-07
Vermont	23.2	24.0	1900-07
Connecticut	26.9	16.6	1900-07
South Dakota	31.1	20.0	1906-07
Michigan	32.4	23.7	1900-07
Maryland	41.1	39.8	1906-07
Maine	41.8	23.1	1900-07
Indiana	42.6	40.0	1901-07
California	45.7	28.2	1906-07
Colorado	62.2	58.5	1906-07
Pennsylvania	72.1	36.8	1906-07

The Census Bureau's definition of urban is any community of 8,000 population in 1900, no account being taken of the cities which may have increased to 8,000 or over since the Census. The rural is the remaining population of the registration state. It will be noticed that in the states whose urban rates are under 25 the rural rate is slightly higher in three, New York, Vermont and Rhode Island. In the other three the rural rate is lower, especially in Massachusetts and New Jersey. In the states with urban rates above 25 we find the difference in favor of the rural rate increasing as the amount of known water-borne typhoid increases, reaching a maximum in Pennsylvania, where the rural rate is but a trifle more than half the urban rate. It must be remembered that included in this rural rate are a large number of towns of from 5,000 to 8,000 population whose water-supplies are badly polluted.

In Maryland, Indiana and Colorado the rural rate is very high and nearly equal to the urban rate. Possibly the numerous small mining camps of Colorado might furnish an explanation for this state. In Maryland and Indiana we have a condition that seems universal over the southern states. In the northern states where there is much water-borne typhoid we expect a marked contrast between the urban and rural rates, as in Maine and Pennsylvania. The rates of Maryland and Indiana are the same as those of Washington, D. C., since filtration and are of the same order as the better of the southern cities. It seems highly improbable that water-borne typhoid should prevail over the rural and urban areas of these two states with such equal intensity. It is more likely that here, as in Washington, D. C., we must accept the conclusion of the U. S. Public-Health and Marine Hospital Service investigation and say that polluted water is not the most important factor.

Another factor to be considered is the geographical distribution of the disease in these states. Indiana is cut in halves by the 40th parallel of north latitude, while Maryland lies entirely south of this parallel but in its western mountain countries has a considerable region which, climatically viewed, is north of this line. Taking as a basis of study the rural population, which, because of its covering the whole territory, is a more satisfactory index of conditions than the urban population occupying restricted areas and strongly influenced by local conditions, such as polluted water supplies, we have the rural rates from the Mortality Reports.

Rural	Years	Mean pop.	Typhoid death rate Ave.	Max.	Min.
Northern, Ind.	1901-07	1,069,993	31.8	37.3	23.8
Southern, Ind.	1901-07	938,022	49.0	63.7	40.0
Eastern Shore, Md.	1906-07	203,780	56.2	61.0	51.4
Western Shore, Md.	1906-07	296,260	36.7	38.3	34.6
Mountain, Md.	1906-07	137,790	23.9	27.0	20.9

The division follows the county lines, that being the statistical unit. In Indiana the line runs north of Vermillion Co., north of Marion Co. (Indianapolis), south of Wayne Co. (Richmond); in Maryland the mountain countries are Garret, Alleghany, Washington, and Frederick, while Carroll, Howard and Montgomery, east of the Monocacy River, are in the Western Shore district.

In Engineering News of Feb. 10, 1910, Prof. Edward Bartow finds a similar distribution of typhoid fever in Illinois. He attributes the lower rates of the northern counties to the geological conditions which permit the northern section to obtain pure water supplies much easier than in the south. Unquestionably the ease with which pure water can be obtained plays an important part in Indiana and elsewhere but it seems to the writer that the increased rates in the warmer sections of these states are too constantly maintained to be ascribed chiefly to water-borne infection.

The one general factor applicable in Maryland, Indiana, and Illinois, in Washington, D. C., and in the other Southern registration cities, is that of temperature. How this operates and what its connection is with the increased amount of typhoid in the northern states in August, September and October, remains to be answered. The admission of more Southern and Border states to the registration list will enable the relation between typhoid and temperature to be determined more definitely.

In Table II. the states are grouped first into Registration States, then Northern Non-Registration States, and last Southern Non-Registration States. Registration states are those whose returns of deaths are accepted by the Census Bureau, and the population given in the table is the total urban population of the several states. In the non-registration states only registration cities are used in the table, and the population given is not the total urban population of the state, the urban population which is not accepted by the Census Bureau being given in the next column. From a comparison of the two columns it will be seen that in some of the states, as Minnesota, Nebraska and Louisiana, the registration population comprises 75% or more of the total urban population, while in others, as Kansas and Texas, less than 25% of the urban population is registration. This must be considered in comparing the typhoid

TABLE I.—TYPHOID STATISTICS OF CITIES OF THE UNITED STATES, 1898-1908.

(Compiled from Mortality Statistics of the U. S. Census Bureau, and various State Reports.)

City and State.	Years.	Typhoid death rate per 100,000 population. Average.	Highest.	Lowest.	Population, 1900.
Cities with Typhoid Death Rate between 0 and 10 per 100,000.					
Lincoln, R. I.	1906-08	3.6	10.8	0	8,937
Marlboro, Mass.	1898-08	4.5	14.3	0	13,609
Auburn, Me.	1906-08	4.7	14.0	0	12,951
Mt. Carmel, Pa.	1900-08	4.8	15.2	0	13,179
W. Hoboken, N. Y.	1905-08	5.0	9.9	0	23,094
Brookline, Mass.	1898-08	5.5	13.7	0	19,935
Ware, Mass.	1898-08	5.5	12.5	0	8,263
Madison, Wis.	1900-08	5.8	18.7	0	19,164
Pasadena, Cal.	1906-08	6.0	12.0	0	9,117
Warwick, R. I.	1906-08	6.4	11.2	0	21,316
Iron M'nt'n, Mich.	1900-08	7.9	23.8	0	9,242
Bloomfield, N. J.	1905-08	8.2	16.6	0	9,668
Watertown, Mass.	1898-08	9.3	40.5	0	9,706
Shamokin, Pa.	1906-08	9.6	14.4	4.7	18,202
Shenandoah, Pa.	1906-08	9.9	16.8	4.3	20,321
Cities with Typhoid Death Rate between 10 and 20 per 100,000.					
Leominster, Mass.	1898-08	10.0	22.6	0	12,392
Concord, N. H.	1900-08	10.2	19.6	0	19,632
Nashua, N. H.	1900-08	10.7	19.4	3.7	23,898
Woonsocket, R. I.	1900-08	10.7	28.4	3.4	28,204
Bath, Me.	1901-08	11.1	26.8	0	10,477
Yonkers, N. Y.	1898-08	11.6	19.8	4.9	47,931
Arlington, Mass.	1898-08	11.8	34.0	0	8,603
Vernon, Conn.	1898-08	12.0	24.1	0	8,483
Newton, Mass.	1898-08	12.2	26.8	5.2	33,587
Winona, Minn.	1900-08	12.2	35.5	0	19,714
East Orange, N. J.	1905-08	12.3	18.3	7.5	21,506
Laconia, N. H.	1900-08	12.4	24.9	0	8,042
Attleboro, Mass.	1898-08	12.5	37.2	0	11,335
Quincy, Mass.	1898-08	12.4	38.5	0	23,899
Kearny, N. J.	1905-08	12.5	29.4	0	10,896
Peabody, Mass.	1898-08	12.6	42.7	0	11,523
Pittston, Pa.	1900, 06-08	12.8	21.6	0	12,556
Woburn, Mass.	1898-08	12.8	28.2	0	14,254
Cambridge, Mass.	1898-08	13.0	21.8	8.0	91,886
Holyoke, Mass.	1898-08	13.0	24.1	5.8	45,712
Hyde Park, Mass.	1898-08	13.0	22.2	7.0	13,244
Mahanoy City, Pa.	1900-08	13.1	34.2	0	13,504
Union, N. J.	1900-08	13.2	25.1	6.1	15,187
Revere, Mass.	1898-08	13.4	30.5	0	10,395
St. Joseph, Mo.	1898-08	13.4	34.0	6.7	102,979
Keene, N. H.	1900-08	13.5	39.9	0	9,165
Melrose, Mass.	1898-08	13.5	31.9	0	12,962
Manitowoc, Wis.	1900-05, 08	13.7	25.1	0	11,376
Wallingford, Conn.	1898-08	13.7	55.5	0	9,001
Middletown, O.	1900-08	14.0	32.5	0	9,215
Norwich, Conn.	1898-08	14.4	28.1	4.2	24,637
Ann Arbor, Mich.	1900-08	14.5	20.7	5.8	14,509
Fitchburg, Mass.	1898-08	14.6	31.7	3.1	31,531
Beloit, Wis.	1900-08	15.0	45.1	0	10,436
Medford, Mass.	1898-08	15.0	28.6	4.9	18,244
Rochester, N. Y.	1898-08	15.0	18.5	11.5	162,698
Rockland, Me.	1900-08	15.0	36.8	0	8,150
Chicopee, Mass.	1898-08	15.1	32.2	0	19,167
Weymouth, Mass.	1898-08	15.1	35.2	0	11,324
Central Falls, R. I.	1900-08	15.2	32.1	5.0	18,167
Mt. Vernon, N.Y.	1898-08	15.3	37.9	5.0	21,228
Worcester, Mass.	1898-08	15.3	27.0	10.5	118,421
Hackensack, N. J.	1905-08	15.4	27.0	0	9,443
Somerville, Mass.	1898-08	15.5	24.4	7.7	61,643
Oneida, N. Y.	1898-08	15.6	38.0	0	6,364
Torrington, Conn.	1898-08	15.6	33.8	0	12,453
Wakefield, Mass.	1898-08	15.6	36.9	0	9,290
Fall River, Mass.	1898-08	15.7	25.7	7.6	104,863
Milford, Mass.	1898-08	15.7	40.8	0	11,376
Bradford, Pa.	1906-08	15.8	23.4	5.9	15,029
Plymouth, Mass.	1898-08	15.8	55.0	0	9,592
Gloucester, Mass.	1898-08	16.0	33.9	3.8	26,121
E. Providence, R.I.	1906-08	16.3	21.3	13.6	12,138
Pawtucket, R. I.	1898-08	16.3	25.5	2.2	39,231
St. Paul, Minn.	1898-08	16.3	26.3	10.4	163,065
Bridgeport, Conn.	1898-08	16.5	26.0	9.9	70,996
Stonington, Conn.	1898-08	16.5	44.7	0	8,540
Webster, Mass.	1898-08	16.7	59.5	0	8,804
Appleton, Wis.	1900-06, 08	16.8	34.5	5.5	15,085
Brockton, Mass.	1898-08	17.0	45.0	7.5	40,063
Harrison, N. J.	1900-08	17.1	47.2	0	10,596
Meriden, Conn.	1898-08	17.2	33.7	6.7	28,035
Perth Amboy, N. J.	1900-08	17.3	30.9	0	17,699
Cumberland, R. I.	1906-08	17.4	52.3	0	8,925
Gardner, Mass.	1898-08	17.5	54.3	0	10,813
Everett, Mass.	1898-08	17.6	30.2	7.4	24,336
New York, N. Y.	1898-08	17.6	20.8	12.3	3,437,202
Rochester, N. H.	1900-08	17.6	34.1	0	8,466
Ansonia, Conn.	1898-08	17.7	44.8	0	12,681
Naugatuck, Conn.	1898-08	17.7	49.5	0	10,541
Elizabeth, N. J.	1898-08	17.9	27.9	7.7	52,130
Schenectady, N.Y.	1898-08	17.9	38.0	3.3	31,682
Middletown, Conn.	1898-08	18.0	31.8	0	17,486
Carlisle, Pa.	1900-08	18.1	48.9	0	9,626
Hoboken, N. J.	1898-08	18.3	30.4	9.7	59,364
Owosso, Mich.	1900-08	18.4	44.8	0	8,696
Jersey City, N. J.	1898-08	18.5	34.4	9.7	206,433
Manchester, N. H.	1898-08	18.5	29.7	10.5	56,987
Montclair, N. J.	1900-08	18.5	44.1	5.6	13,962
Greenwich, Conn.	1898-08	18.6	39.1	0	12,172
Lynn, Mass.	1898-08	18.6	23.9	12.5	68,513
Rutland, Vt.	1900-08	18.9	34.1	0	11,499
Bayonne, N. J.	1900-08	19.0	43.0	0	32,722
New Rochelle, N.Y.	1898-08	19.1	37.1	7.1	14,720
Newark, N. J.	1898-08	19.2	26.8	12.2	246,070
Syracuse, N. Y.	1898-08	19.2	43.3	8.0	108,374
Utica, N. Y.	1898-08	19.3	27.7	12.6	56,383
Olean, N. Y.	1898-08	19.4	41.2	0	9,462
Passaic, N. J.	1900-08	19.4	42.3	7.9	27,777
Burlington, Vt.	1900-08	19.5	37.6	9.1	18,640
Kingston, N. Y.	1898-08	19.5	31.5	4.2	24,535
Malden, Mass.	1898-08	19.5	29.0	10.5	33,664
Providence, R. I.	1898-08	19.6	25.0	8.2	175,597
Milwaukee, Wis.	1898-08	19.7	30.5	13.6	285,315
Windham, Conn.	1898-08	19.7	39.6	0	10,137
Lowell, Mass.	1898-08	19.8	32.7	7.4	94,969
Titusville, Pa.	1906-08	19.9	35.9	11.9	8,244
Cities with Typhoid Death Rate between 20 and 30 per 100,000.					
Gloversville, N. Y.	1898-08	20.0	49.0	5.4	18,349
Haverhill, Mass.	1898-08	20.1	26.7	13.3	37,175
New Britain, Conn.	1898-08	20.2	34.1	7.3	28,202
San Diego, Cal.	1900-08	20.2	39.0	5.5	17,700
Manchester, Conn.	1898-08	20.4	75.5	0	10,601
Ottawa, Ill.	1900-08	20.4	56.1	0	10,588
New London, Conn.	1898-08	20.5	38.2	5.2	17,548
San Jose, Cal.	1900-08	20.6	37.1	4.5	21,500
Eau Claire, Wis.	1900-08	20.7	51.4	5.4	17,517
Southbridge, Mass.	1898-08	20.7	57.6	0	10,025
Detroit, Mich.	1898-08	20.9	28.3	16.9	285,704
Paterson, N. J.	1898-08	20.9	46.5	7.9	105,171
Danbury, Conn.	1898-08	21.0	42.2	5.1	19,474
Tiffin, O.	1900-08	21.1	54.3	0	10,989
Danvers, Mass.	1898-08	21.2	44.1	0	8,542
Lebanon, Pa.	1900, 06-08	21.2	34.0	10.2	17,628
Natick, Mass.	1898-08	21.3	54.6	0	9,488
Sioux City, Ia.	1900-05	21.3	39.3	9.7	33,111
Pontiac, Mich.	1900-08	21.4	49.8	8.0	9,769
Chelsea, Mass.	1898-08	21.5	32.7	7.6	34,072
Stockton, Cal.	1906-08	21.7	23.0	20.0	17,506
Bridgeton, N. J.	1900-08	21.8	43.9	0	13,913
Camden, N. J.	1898-08	22.0	43.5	13.7	75,925
Taunton, Mass.	1898-08	22.0	35.5	6.5	31,036
Framingham, Mass.	1898-08	22.2	104.0	0	11,302
Hazleton, Pa.	1900-08	22.5	32.2	12.5	14,230
Auburn, N. Y.	1898-08	22.6	50.2	6.0	30,345
Westfield, Mass.	1898-08	22.6	37.5	0	12,310
Homestead, Pa.	1906-08	22.9	37.4	12.0	12,554
Muskegon, Mich.	1900-08	22.9	33.4	14.3	20,818
Johnstown, N. Y.	1898-08	23.0	69.1	0	10,130
Orange, N. J.	1900-08	23.0	40.1	12.2	24,141
Lincoln, Neb.	1898-08	23.1	39.1	9.8	40,169
Omaha, Neb.	1898-08	23.1	31.2	11.5	102,555
Atlantic City, N. J.	1900-08	23.2	38.0	15.8	27,838
South Bend, Ind.	1898, 00-08	23.2	44.6	14.9	35,999
Boston, Mass.	1898-08	23.3	33.0	10.5	560,892
Lawrence, Mass.	1898-08	23.4	31.9	17.5	62,559
Portsmouth, N. H.	1900-08	23.4	55.6	0	10,637
Beverly, Mass.	1898-08	23.5	37.4	7.1	13,884
Northampton, Mass.	1898-08	23.8	60.3	5.2	18,643
Pittsfield, Mass.	1898-08	23.8	40.0	9.3	21,766
Plattsburg, N. Y.	1898-08	23.8	61.3	0	8,434
New Brunswick, N.J.	1900-08	23.9	35.5	4.2	20,006
Colo. Spgs., Colo.	1906-08	24.2	30.7	19.0	21,085
Akron, O.	1898-07	24.3	38.0	10.0	42,728
Decatur, Ill.	1900-08	24.4	48.2	11.8	20,754
Saginaw, Mich.	1898-08	24.4	49.3	9.0	42,345
Springfield, Mass.	1898-08	24.5	29.8	15.4	62,059
Nanticoke, Pa.	1906-08	24.8	52.4	7.4	12,116
Chicago, Ill.	1898-08	25.3	45.1	15.3	1,698,575
Millville, N. J.	1900-08	25.3	45.0	0	10,583
Rome, N. Y.	1898-08	25.4	40.4	6.5	15,343
Salem, Mass.	1898-08	25.5	46.0	12.9	35,957
Plainfield, N. J.	1900-08	25.6	50.4	5.1	15,369
New Bedford, Mass.	1898-08	25.7	50.3	8.1	62,442
Plymouth, Pa.	1900-08	25.7	51.3	6.0	13,649
Ishpeming, Mich.	1900-08	25.8	83.0	0	13,255
Jamestown, N. Y.	1898-08	25.9	40.5	4.1	22,892
Newark, O.	1900-08	26.3	60.6	10.1	18,157
Barre, Vt.	1900-08	26.8	47.4	0	8,448
Bennington, Vt.	1900-08	26.9	67.8	0	8,033
Buffalo, N. Y.	1898-08	27.0	34.6	20.7	352,387
Newport, R. I.	1900-08	27.1	90.8	3.8	22,034
Green Bay, Wis.	1900-08	27.5	41.0	9.4	18,684

City and State.	Years.	Typhoid death rate per 100,000 population. Average.	High-est.	Low-est.	Population, 1900.
Oakland, Cal.	1898-08	27.5	43.8	11.7	66,960
Warren, Pa.	1906-08	27.5	37.6	8.7	8,043
Alameda, Cal.	1900-08	27.7	43.5	0	16,464
St. Louis, Mo.	1898-08	27.7	52.4	15.3	575,585
Lewiston, Me.	1906-08	27.8	32.0	23.8	23,761
Dayton, O.	1898-08	28.0	44.4	16.8	83,333
Richmond, Ind.	1900-08	28.2	59.3	5.1	18,226
Clinton, Mass.	1898-08	28.4	62.5	0	13,667
Dunmore, Pa.	1906-08	28.4	66.0	0	12,583
Stamford, Conn.	1898-08	28.6	61.7	6.6	18,839
Hartford, Conn.	1898-08	28.7	47.6	13.3	79,850
Massillon, O.	1900-08	28.7	100.5	0	11,944
Middletown, N. Y.	1898-08	28.8	42.7	0	14,522
Scranton, Pa.	1898-08	28.8	75.8	10.7	102,026
Binghamton, N. Y.	1898-08	28.9	70.7	9.4	39,647
Waltham, Mass.	1898-08	29.0	53.3	14.3	23,481
Canton, O	1898-08	29.3	66.7	12.7	30,667
Davenport, Ia.	1898-05	29.5	42.6	8.5	35,254
Kalamazoo, Mich.	1898-08	29.6	43.1	17.7	24,404
Cities with Typhoid Death Rate between 30 and 40 per 100,000.					
Amesbury, Mass.	1898-08	30.0	55.8	0	9,473
Waterbury, Conn.	1898-08	30.0	54.5	18.3	51,139
Fort Wayne, Ind.	1898-08	30.2	39.6	16.0	45,115
Portland, Ore.	1898-08	30.5	41.0	21.5	90,426
Berkeley, Cal.	1906-08	30.6	40.0	14.0	13,214
Chambersburg, Pa.	1906-08	30.7	40.6	20.5	8,864
Aurora, Ill.	1900-08	30.7	70.4	7.6	24.147
Lorain, O.	1898-07	31.1	75.0	0	16,028
Tonawanda, N. Y.	1898-08	31.1	95.6	0	7,421
York, Pa.	1898-08	31.2	80.0	12.2	33,708
No.Tonawanda,N.Y.	1898-08	31.3	55.7	10.5	9,069
Amsterdam, N. Y.	1898-08	31.4	140.8	0	20,929
Marinette, Wis.	1900-08	31.5	51.0	13.5	16,195
Oil City, Pa.	1900, 06-08	31.5	52.8	6.8	13,264
Hornell, N. Y.	1898-08	31.6	76.1	7.3	11,918
Easton, Pa.	1906-08	32.0	45.9	19.8	25,238
Wilkes-Barre,Pa.	1900, 06-08	32.0	45.5	23.8	51,721
Wabash, Ind.	1901-08	32.1	67.9	0	8,618
Adrian, Mich.	1906-08	32.2	44.7	17.1	9,654
Hamilton, O.	1900-08	32.7	54.2	14.8	23,914
Portland, Me.	1898-08	32.7	71.8	16.3	50.145
Cranston, R. I.	1906-08	32.8	36.3	27.2	13,343
North Adams, Mass.	1898-08	33.1	56.6	4.1	24,200
Sioux Falls, S. Dak.	1906-08	33.1	39.4	22.9	10,266
Elkhart, Ind.	1901-08	33.3	56.3	5.5	15,184
Dover, N. H.	1900-08	33.4	51.7	22.4	13,207
Norwalk, Conn.	1898-08	33.4	54.6	5.2	19,932
Batavia, N. Y.	1904, 06-08	33.7	49.6	18.9	9,180
Fulton, N. Y.	1898-08	33.7	93.2	0	5,281
Cortland, N. Y.	1898-08	34.0	117.6	8.2	9.014
Galveston, Tex.	1906-08	34.0	42.6	26.2	37,789
Traverse City, Mich.	1900-08	34.5	90.5	0	9,407
Minneapolis, Minn.	1898-08	34.9	58.7	17.8	202,718
Geneva, N. Y.	1898-08	35.0	55.7	0	10,433
Manistee, Mich.	1906-08	35.0	51.9	8.4	14,260
Seattle, Wash.	1898-08	35.3	69.2	20.0	80,671
Baltimore, Md.	1898-08	35.5	42.0	28.7	508,957
Hagerstown, Md.	1906-08	35.5	49.9	18.3	13,591
Toledo, O.	1898-08	35.8	45.7	23.6	136,515
Albany, N. Y.	1898-08	36.0	100.0	12.0	94,151
Quincy, Ill.	1898-08	36.0	56.4	20.2	36,252
Tacoma, Wash.	1898-08	36.0	61.8	13.2	37,714
Battle Creek, Mich.	1900-08	36.2	56.5	14.7	18,563
Little Falls, N. Y.	1898-08	36.5	125.2	0	10,381
Phillipsburg, N. J.	1900-08	36.5	102.1	0	10,052
Lima, Ohio	1900-08	36.6	73.7	13.8	21,723
Anderson, Ind.	1901-08	36.7	71.0	14.9	20,178
Los Angeles, Cal.	1898-08	36.8	47.0	24.0	102,419
Huntington, Ind.	1901-08	37.4	82.3	8.9	9,491
Erie, Pa.	1898-08	37.5	78.4	13.3	52,733
Cleveland, O.	1898-08	37.8	115.0	12.6	381,768
Oneonta, N. Y.	1899-08	37.9	68.2	13.6	7,147
Port Huron, Mich.	1900-08	37.9	61.2	14.8	19,158
Morristown, N. J.	1900-08	38.0	90.6	16.7	11,267
Memphis, Tenn.	1898-08	38.7	51.8	22.4	102,320
Peekskill, N. Y.	1900-08	38.7	201.3	9.7	10,358
Bay City, Mich.	1900-08	38.8	49.3	22.0	40,747
Kokomo, Ind.	1901-08	38.9	94.6	8.7	10,609
Newburgh, N. Y.	1898-08	39.0	48.4	25.9	24,943
Newburyport, Mass.	1898-08	39.1	81.1	13.7	14,478
Indianapolis, Ind.	1898-08	39.3	68.4	26.4	169,164
Covington, Ky.	1898-08	39.8	53.5	27.6	42,938
Dunkirk, N. Y.	1898-08	39.9	76.6	8.9	11,616
Pottsville, Pa.	1900-08	39.9	58.9	12.2	15,710
Cities with Typhoid Death Rate between 40 and 50 per 100,000.					
Newport, Ky.	1900-08	40.1	75.0	7.0	28,301
Findlay, Ohio	1900-08	40.4	113.6	0	17,613
Grand Rapids Mich.	1898-08	40.4	61.6	29.7	87,565
New Haven, Conn.	1898-08	40.5	94.4	25.9	108,027
Carbondale, Pa.	1900-08	40.6	67.9	6.6	13,536
Flint, Mich.	1900-08	40.8	68.8	19.7	13,103
Michigan City, Ind.	1900-08	41.3	68.4	13.1	14,850
Port Jervis, N. Y.	1898-08	41.6	92.8	0	9,385
Lafayette, Ind.	1901-08	41.8	81.1	15.4	18,116
Trenton, N. J.	1898-08	41.8	80.2	18.5	73,307
San Francisco, Cal.	1898-08	42.0	75.0	16.7	342.782
Sunbury, Pa.	1906-08	42.0	71.7	8.8	9,810
Ironwood, Mich.	1900-08	42.2	82.4	0	9,705
Evansville, Ind.	1898-08	42.3	66.1	26.7	59,007
Elmira, N. Y.	1898-08	42.5	80.8	28.0	35,672
Jackson, Mich.	1900-08	42.7	67.5	19.7	25,180
Glens Falls, N. Y.	1898-08	42.7	84.5	14.9	12,613
Kansas City, Mo.	1898-08	43.0	80.3	25.1	163,752
Leavenworth, Kan.	1900-08	43.2	84.7	22.6	20,735
Springfield, Ill.	1898-08	43.4	85.8	25.8	34,159
New Orleans, La.	1898-08	43.7	64.1	29.6	287,104
Saratoga Spgs., N.Y.	1900-08	44.1	71.8	22.5	12,409
Chester, Pa.	1906-08	44.2	65.8	25.4	33,988
Savannah, Ga.	1898-08	44.4	78.8	22.5	52.244
Marion, Ind.	1901-08	44.7	82.4	7.7	17,337
Williamsport, Pa.	1900-08	44.8	71.0	17.3	28,757
Dubois, Pa.	1900-08	44.9	77.4	16.7	9,375
Reading, Pa.	1898-08	45.0	66.2	25.8	78,961
Corning, N. Y.	1898-08	45.1	87.5	16.7	11,061
Elwood, Ind.	1901-08	45.2	59.8	23.4	12,950
Jacksonville, Ill.	1900-08	45.7	101.8	17.9	15,078
Marquette, Mich.	1900-08	45.9	79.5	19.6	10,058
Altoona, Pa.	1898-08	46.1	68.9	24.5	38,973
Annapolis, Md.	1900-08	46.1	77.9	10.9	8,525
Logansport, Ind.	1901-08	46.5	73.7	16.5	16,204
Frederick, Md.	1900-08	46.5	88.4	10.2	9,296
Lansing, Mich.	1900-08	46.6	76.7	10.9	16,485
Poughkeepsie, N. Y.	1898-08	46.7	117.2	21.1	24,029
Superior, Wis.	1898-08	46.7	125.9	15.1	31,091
Mankato, Minn.	1900-08	47.0	276.0	0	10,599
Oswego, N. Y.	1898-08	47.0	84.1	17.0	22,190
Belleville, Ill.	1900-08	47.2	77.3	26.7	17,484
Ithaca, N. Y.	1898-08	47.2	336.9	0	13,186
Waterville, Me.	1898-08	47.8	176.6	0	9,477
Lancaster, Pa.	1898-08	48.0	79.6	14.3	41,459
Adams, Mass.	1898-08	48.1	81.5	0	11,134
Denver, Colo.	1898-08	48.8	68.5	30.3	133,859
Alpena, Mich.	1906-08	49.2	69.2	23.3	11,802
Bristol, Conn.	1898-08	49.1	137.9	18.6	9,643
Wilmington, Del.	1898-08	49.7	94.7	23.9	76,508
Cities with Typhoid Death Rate between 50 and 60 per 100,000.					
Cincinnati, O.	1898-08	50.7	80.2	18.6	325,902
Berlin, N. H.	1900-08	50.8	123.8	8.0	8,886
So. Bethlehem, Pa.	1900-08	51.0	205.3	13.1	13,241
Key West, Fla.	1900-08	51.2	109.8	10.4	17,114
Burlington, Ia.	1900-05	51.5	56.2	45.0	23,201
Vincennes, Ind.	1901-08	51.8	118.1	16.9	10,249
Ottumwa, Ia.	1900-03	52.2	65.9	36.0	18,197
Wichita, Kan.	1900-08	52.2	114.4	28.1	24,671
Bellaire, O.	1900-08	52.8	90.8	20.2	9,912
Ashtabula, O.	1900-08	53.3	137.1	7.7	12,949
Terre Haute, Ind.	1898-08	53.4	75.0	36.6	36,673
Philadelphia, Pa.	1898-08	53.6	74.8	34.6	1,293,697
Meadville, Pa.	1900-08	53.9	105.3	17.2	10,291
Muncie, Ind.	1900-08	53.9	95.5	16.4	20,942
New Albany, Ind.	1901-08	54.5	135.7	14.5	20,628
Peru, Ind.	1900-08	54.5	130.0	16.6	8,463
Norristown, Pa.	1900-08	55.0	77.4	37.5	22,265
Richmond, Va.	1898-08	55.0	88.3	34.1	85,050
Biddeford, Me.	1900-08	55.2	116.5	5.7	16,145
Washington, D. C.	1898-08	55.5	79.1	35.5	278,718
San Antonio, Tex.	1899-08	55.7	89.9	28.7	53,821
Allentown, Pa.	1898-08	55.8	189.5	25.4	35,416
Duluth, Minn.	1898-08	56.1	94.5	37.8	52,969
Alexandria, Va.	1900-08	56.4	102.7	27.5	14,528
Lockport, N. Y.	1898-08	56.4	145.7	18.0	16,581
Louisville, Ky.	1898-08	57.4	67.9	46.0	204,731
Columbus, O.	1898-08	57.5	147.7	22.3	125,560
Ogdensburg, N. Y.	1898-08	57.5	95.0	20.4	12,633
Troy, N. Y.	1898-08	58.5	155.0	27.4	60,651
Norfolk, Va.	1898-08	58.5	80.3	33.5	46,624
Pottstown, Pa.	1900-08	58.5	86.6	28.7	13,696
Nashville, Tenn.	1898-08	58.6	82.6	27.2	80,865
Columbia, Pa.	1900-08	58.7	122.3	14.5	12,316
Watervliet, N. Y.	1898-08	58.8	105.7	41.2	14,321
Columbus, Ind.	1900-08	59.0	123.0	23.8	8,130
Harrisburg, Pa.	1898-08	59.1	103.9	31.9	50,167
Cities with Typhoid Death Rate between 60 and 70 per 100,000.					
Marietta, O.	1900-08	60.4	115.5	18.3	13,348
Mobile, Ala.	1898-08	60.4	106.7	35.0	38,469
Duquesne, Pa.	1906-08	62.1	111.7	0	9,036
Hudson, N. Y.	1898-08	62.1	106.7	9.3	9,528
Salt Lake City, Utah	1898-08	62.3	101.8	20.6	53,531
Washington, Ind.	1901-08	62.3	125.0	22.1	8,551
Conneaut, O.	1898-08	62.3	178.0	0	7,133
Bangor, Me.	1900-08	63.2	187.4	22.9	21,850
Jeffersonville, Ind.	1900-08	63.6	111.3	27.7	10,714
Chillicothe, O.	1900-08	65.3	95.2	29.7	12,976
Leadville, Colo.	1900-08	65.3	286.1	14.2	12,455
Johnstown, Pa.	1898-08	65.5	139.4	22.5	35,936
Danville, Pa.	1906-08	66.1	99.1	37.1	8,042
Sacramento, Cal.	1900-08	66.7	91.8	36.8	29,282
Long Branch, N. J.	1900-08	67.2	90.2	48.0	8,872
Spokane, Wash.	1898-08	67.5	97.9	39.0	36,848
Portsmouth, O.	1898-08	68.5	89.7	46.0	17,870
Menominee, Mich.	1900-08	69.0	117.2	25.1	12,818
Rensselaer, N. Y.	1898-08	69.7	148.0	18.6	7,466
Cities with Typhoid Death Rate Between 70 and 100 per 100,000					
Atlanta, Ga.	1898-08	72.6	102.5	60.8	89,872
Muscatine, Ia.	1900-05	74.4	120.8	35.0	14,078
Ironton, O.	1898-08	76.5	106.2	33.1	11,868
Watertown, N. Y.	1898-08	76.9	211.7	23.7	21,696
Wilmington, N. C.	1900-08	77.9	100.1	50.9	20,976
Beaver Falls, Pa.	1906-08	77.9	117.1	29.1	10,054
Paducah, Ky.	1900-08	79.4	138.8	42.9	19,446
Augusta, Me.	1898-08	80.8	232.7	32.0	11,638
Charleston, S. C.	1898-08	81.1	131.0	47.8	55,807
Raleigh, N. C.	1900-08	83.0	132.7	42.5	13,643
McKeesport, Pa.	1898-08	85.5	142.7	40.9	34,227
Petersburg, Va.	1900-08	85.6	137.6	50.4	21,810
Butler, Pa.	1906-08	86.7	105.4	55.8	10,853
S'lt Ste.Marie, Mich.	1900-08	87.1	172.9	16.5	10,538
Lynchburg, Va.	1900-08	87.9	121.8	58.2	18,891
Hammond, Ind.	1901-08	88.0	166.0	40.3	12,376
Jacksonville, Fla.	1900-08	88.1	155.1	35.2	28,429
Newcastle, Pa.	1900-08	88.7	192.5	32.6	28,339
Cohoes, N. Y.	1898-08	89.2	118.5	54.0	23,910
Wheeling, W. Va.	1898-08	89.5	125.3	66.1	38,878
Phoenixville, Pa.	1906-08	90.9	134.4	43.5	9,196
Wilkinsburg, Pa.	1906-08	91.8	188.8	41.9	11,886
Steelton, Pa.	1900-08	98.3	276.6	32.3	12,086
Youngstown, O.	1898-08	98.4	180.0	46.0	44,885
Cities with Typhoid Death Rate over 100 per 100,000.					
Allegheny, Pa.	1898-07	103.7	136.3	56.2	129,896
West Chester, Pa.	1906-08	113.4	123.0	95.9	9,524
Cumberland, Md.	1906-08	115.8	148.5	77.5	17,128
Pittsburg, Pa.	1898-08	116.9	144.2	46.6	321,616
Pueblo, Colo.	1900-08	121.2	311.7	57.7	27,157
Braddock, Pa.	1906-08	121.3	146.4	98.0	15,654
Niagara Falls, N. Y.	1898-08	130.8	181.6	98.0	19,457
Fresno, Cal.	1900-08	132.1	240.6	60.9	12,470
Escanaba, Mich.	1900-08	139.3	351.4	28.0	9,549
Sharon, Pa.	1906-08	184.0	244.4	109.2	8,916

TABLE II.—URBAN POPULATIONS OF REGISTRATION STATES AND OF REGISTRATION CITIES IN BOTH NORTHERN AND SOUTHERN NON-REGISTRATION STATES, SHOWING PERCENTAGES OF URBAN POPULATION IN EACH GROUP OF TYPHOID DEATH RATES.

State	Typhoid Death Rate between 0-10. Pop.	%	10-20. Pop.	%	20-30. Pop.	%	30-40. Pop.	%	40-50. Pop.	%	50-60. Pop.	%	60-70. Pop.	%	70-100. Pop.	%	Over 100 Pop.	%	Total Population.	Urban population not included in table.
Registration States.																				
Rhode Island	30,243	8.7	282,262	81.2	22,034	6.3	13,343	3.8	0	0	0	0	0	0	0	0	0	0	347,882	
New Hampshire	0	0	126,190	79.5	10,637	6.6	13,207	8.3	0	0	8,886	5.6	0	0	0	0	0	0	158,650	
New York	0	0	3,920,489	78.4	512,049	10.3	241,841	4.8	140,554	2.8	104,186	2.1	16,994	.3	45,606	.9	19,457	.4	5,001,176	
New Jersey	32,762	2.8	723,785	62.7	292,956	25.4	22,319	1.9	73,307	6.4	0	0	8,872	.8	0	0	0	0	1,154,001	
Vermont	0	0	30,139	64.7	16,481	35.3	0	0	0	0	0	0	0	0	0	0	0	0	46,620	
Massachusetts	51,513	2.4	992,526	46.5	1,029,299	48.2	48,151	2.3	11,134	.5	0	0	0	0	0	0	0	0	2,132,623	
Connecticut	0	0	225,822	38.3	174,514	29.6	71,071	12.1	117,670	20.0	0	0	0	0	0	0	0	0	589,077	
Michigan	9,242	1.2	23,205	3.1	396,295	53.0	111,789	15.0	173,898	23.3	0	0	12,818	1.7	10,538	1.4	9,549	1.3	747,334	
Maine	12,951	7.9	18,627	11.3	23,761	15.4	59,622	36.2	0	0	16,145	9.8	21,850	13.3	11,638	7.1	0	0	164,594	
South Dakota	0	0	0	0	0	0	10,266	100.0	0	0	0	0	0	0	0	0	0	0	10,266	
Maryland	0	0	0	0	0	0	522,548	93.7	17,821	3.2	0	0	0	0	0	0	17,128	3.1	557,497	
Indiana	0	0	0	0	54,225	8.9	278,357	45.8	138,464	22.8	105,085	17.3	19,265	3.2	12,376	2.0	0	0	607,834	
California	9,117	1.4	0	0	140,139	21.6	115,633	17.8	342,782	52.8	0	0	29,282	4.5	0	0	12,470	1.9	649,414	
Colorado	0	0	0	0	21,085	10.8	0	0	133,859	68.4	0	0	12,455	6.4	0	0	28,157	14.4	195,566	
Pennsylvania	51,702	1.8	58,959	2.1	226,537	7.9	167,530	5.8	254,859	8.9	1,451,089	50.6	53,014	1.9	116,614	4.1	485,606	16.9	2,865,810	
Registration Cities, Northern Non-Registration States.																				
Wisconsin	19,164	4.5	322,212	75.7	36,201	8.5	16,195	3.8	31,091	7.3	0	0	0	0	0	0	0	0	425,863	204,000
Minnesota	0	0	182,779	40.7	0	0	202,718	45.2	10,599	2.4	52,969	11.7	0	0	0	0	0	0	448,845	20,000
Missouri	0	0	102,979	12.2	575,585	68.4	0	0	163,752	19.4	0	0	0	0	0	0	0	0	842,316	111,000
Nebraska	0	0	0	0	142,724	100.0	0	0	0	0	0	0	0	0	0	0	0	0	142,724	26,000
Illinois	0	0	0	0	1,929,917	93.1	60,399	3.2	67,721	3.7	0	0	0	0	0	0	0	0	1,857,037	398,000
Iowa	0	0	0	0	68,356	55.2	0	0	0	0	41,938	33.4	0	0	14,073	11.4	0	0	123,836	
Washington	0	0	0	0	0	0	118,385	76.3	0	0	0	0	36,848	23.7	0	0	0	0	155,233	10,000
Ohio	0	0	9,215	.7	157,090	12.0	547,892	41.9	17,613	1.3	474,323	36.3	44,194	3.4	56,753	4.4	0	0	1,370,080	220,000
Oregon	0	0	0	0	0	0	90,426	100.0	0	0	0	0	0	0	0	0	0	0	90,426	8,000
Kansas	0	0	0	0	0	0	0	0	20,735	45.9	24,671	54.1	0	0	0	0	0	0	45,406	139,000
Utah	0	0	0	0	0	0	0	0	0	0	0	0	53,531	100.0	0	0	0	0	53,531	16,000
Registration Cities, Southern Non-Registration States.																				
Tennessee	0	0	0	0	0	0	102,320	55.9	0	0	80,865	44.1	0	0	0	0	0	0	183,185	85,000
Texas	0	0	0	0	0	0	37,789	41.5	0	0	53,821	0	0	0	0	0	0	0	91,110	236,000
Kentucky	0	0	0	0	0	0	42,938	14.5	28,301	9.6	204,731	69.3	0	0	19,446	6.6	0	0	295,416	66,000
Delaware	0	0	0	0	0	0	0	0	76,508	100.0	0	0	0	0	0	0	0	0	76,508	0
Louisiana	0	0	0	0	0	0	0	0	287,104	100.0	0	0	0	0	0	0	0	0	287,104	27,000
Georgia	0	0	0	0	0	0	0	0	52,244	36.8	0	0	0	0	89,872	63.2	0	0	142,116	89,000
Washington, D. C.	0	0	0	0	0	0	0	0	0	0	278,718	100.0	0	0	0	0	0	0	278,718	0
Virginia	0	0	0	0	0	0	0	0	0	0	146,202	77.7	0	0	40,701	22.3	0	0	186,903	82,000
Florida	0	0	0	0	0	0	0	0	0	0	17,114	37.6	0	0	28,429	62.4	0	0	45,543	33,000
Alabama	0	0	0	0	0	0	0	0	0	0	0	0	38,469	100.0	0	0	0	0	38,469	85,000
North Carolina	0	0	0	0	0	0	0	0	0	0	0	0	34,619	100.0	0	0	0	0	34,619	61,000
South Carolina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	55,807	100.0	0	0	55,807	43,000
West Virginia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	38,878	100.0	0	0	38,878	32,000

rates of the various states. Arkansas, Idaho, Mississippi, Montana, Nevada, North Dakota, Oklahoma and Wyoming have no registration population. A few of the cities of Iowa were classed as registration during 1900-03-04, but all have been dropped, so that Iowa is the only state having a considerable urban population which has no registration cities at the present time. Illinois has very few of its smaller cities in the registration lists.

The population of the states has been grouped by increasing typhoid rates. For simplicity of calculation the percentages are based on the 1900 population instead of using a mean figure for the years covered. The states are arranged by the largest percentage below 20 until that percent falls below 25%, when the rate of 30 is taken, and so on.

The states having 50% of their urban population below 20 are all old, thickly settled eastern states, Rhode Island being the leader, with 90% of its population below 20. New York owes its position mainly to the low rate of New York City, while New Hampshire and New Jersey have a considerable population besides Manchester in the former and Newark and Jersey City in the latter with rates below 20.

Massachusetts has only 49% below 20, Boston being in the group between 20 and 30. The majority of the smaller cities of Connecticut are below 20, the rates of Hartford and New Haven accounting for the large percentages in the higher groups. Similarly, Detroit's rate determines the position of Michigan. Maine is conspicuous for the scattering of its cities, no two being in the same group. Colorado and Pennsylvania are the only states having a large percentage with typhoid rate over 100, Pueblo being the offender in Colorado, and Pittsburg, with a number of small towns, in Pennsylvania.

Sectionally, New England shows the best rates, Maine being the only very high state. The western states and most of the cities in the western non-registration states show high typhoid rates.

Wisconsin has a very high percentage below 20 among the northern non-registration states. Minnesota offers an excellent example of the effect of water pollution in the rates of Minneapolis and St. Paul. Minnesota would have had 85% of its population below 20 instead of 40% if Minneapolis had had the same quality of water-supply as St. Paul. Ohio shows conditions approaching those of Pennsylvania.

As already discussed, the typhoid rates of those southern cities for which we have records are uniformly high, indicating that the same conditions prevail in all the southern towns. Whatever may be the cause or causes a study of the rates of the past eleven years offers little hope of an immediate reduction. The elimination of the water pollution will cut down the highest rates, general improvements such as sewers will lower all, yet the fact remains that while the northern cities show a large decrease in typhoid in the years included in this table there has been little change in the southern cities. All of the northern cities with good water-supplies ought to reach rates of 15 and lower during the next ten years, judging from the decrease shown in the period covered by this table.

FIG. 1. MAP OF NORTHERN HALF OF NORFOLK & SOUTHERN RY. LINES, SHOWING LOCATION OF ALBEMARLE SOUND CROSSING.

(Heavy line represents Norfolk & Southern Ry.)

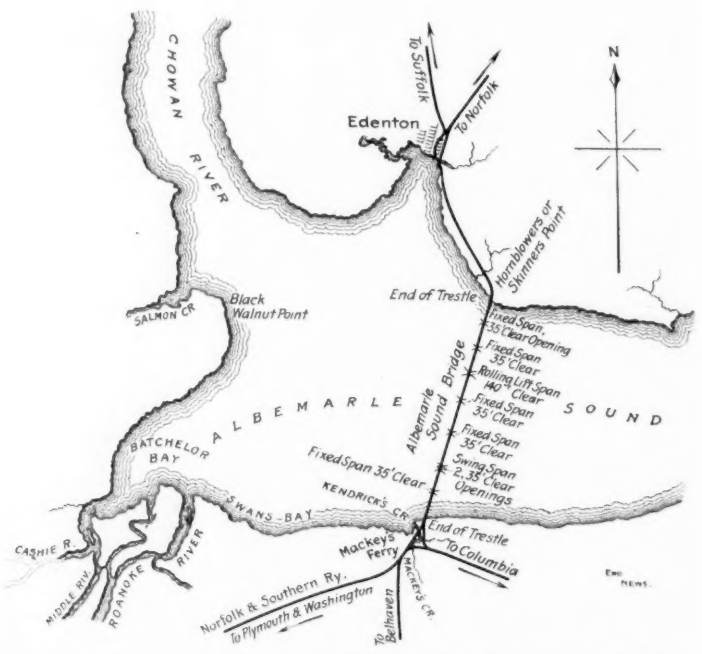

FIG. 2. PLAN OF TRESTLE CROSSING OVER ALBEMARLE SOUND BETWEEN EDENTON AND MACKEY'S FERRY, N. C.; NORFOLK & SOUTHERN RY.

A Five-Mile Trestle Across Albemarle Sound, Norfolk & Southern Ry.

The Norfolk & Southern Ry. has recently completed a five-mile trestle crossing over Albemarle Sound, from Edenton to Mackey's Ferry, N. C. This notable structure gives a track connection between the northern and southern halves of the company's lines, which hitherto have been connected only by a car-ferry (since May, 1899). The business of the road gradually outgrew the capacity of one steamer, and the necessity appeared of either providing a second steamer or establishing a permanent crossing. The increase of freight traffic, present and future, from the rich agricultural and timber sections tributary to the line made it appear that the time had come when economy and good business policy required a fixed crossing to be built.

LOCATION.—The relation of the Sound crossing to the lines north and south of it may be gathered from the map Fig. 1, showing the northeasterly half of the Norfolk & Southern system. Albemarle Sound is about five miles wide at this point, though the distance between Edenton and Mackey's Ferry, the route of the ferry, is several miles greater, as shown by the plan Fig. 2. An approach of 3.6 miles on the north bank and one of ¾-mile on the south bank were required to extend the existing lines to the most favorable point for bridging the Sound. The north approach was on high ground, but the southerly approach was in soft swamp and required a log mattress bedding for the fill.

The water crossing itself is a trifle over 5

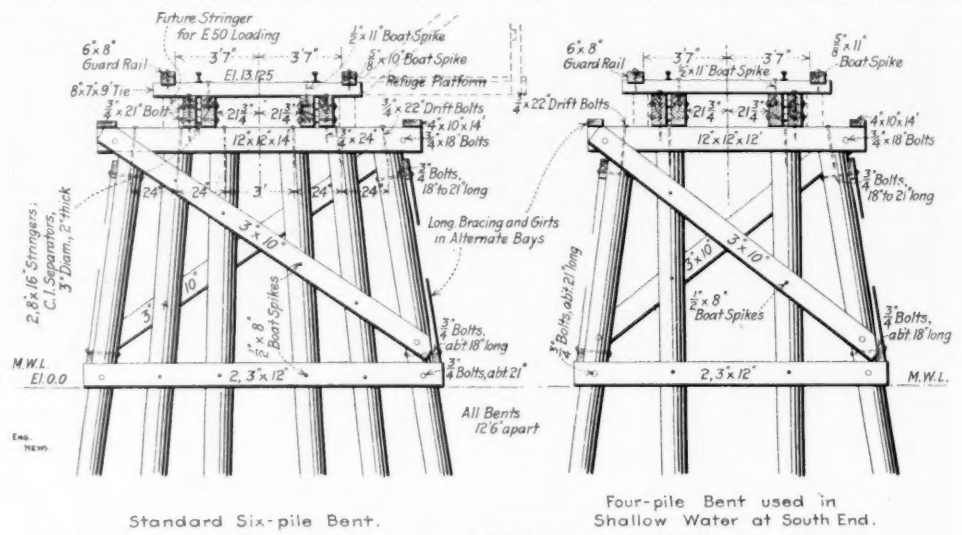

FIG. 3. TRESTLE CONSTRUCTION ON ALBEMARLE SOUND CROSSING, NORFOLK & SOUTHERN RY.

miles long: 26,668 ft. out to out of stringers. The water averages 21 ft. deep over most of the length (19,000 ft.), shoaling at the ends to about 4 ft. The bottom is sand, clay and mud, a

most points capable of giving a good bearing for piles with moderate penetration, but in some places requiring very long piles to reach satisfactory bottom.

The navigation requirements imposed by the War Department called for two movable spans at the two main channels of the Sound, of 140 ft. clear width at the north channel and 35 ft. clear at the south channel, and five fixed openings of 35 ft. width and 12 ft. clearance above water for passage of motorboats.

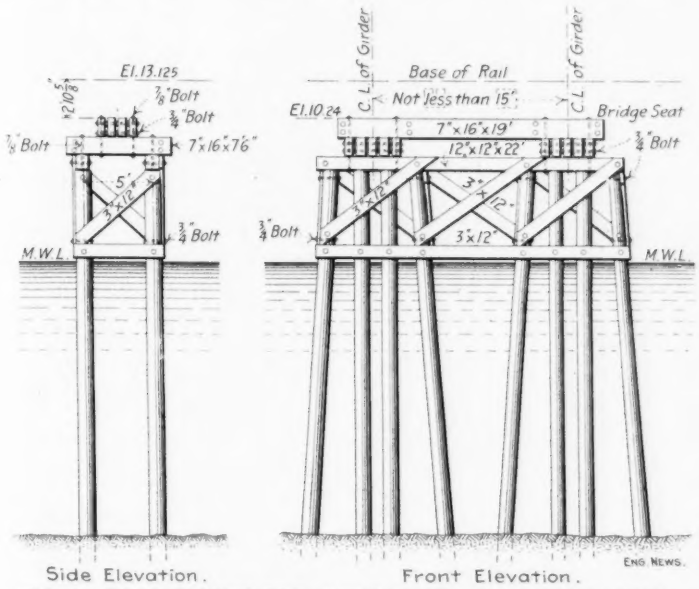

FIG. 4. DOUBLE BENT FOR SUPPORT OF 35-FT. GIRDER SPAN.

GENERAL DESIGN—The structure designed to meet these conditions is as follows: The main part is a timber trestle of 12½ ft. spacing of bents, with six piles per bent. The motorboat spans are through plate-girders, 51½ ft. long end to end, giving 35 ft. clear between fender piles; they were placed generally 3,000 ft apart, in the order shown by Fig. 2. The north channel span is a Scherzer rolling-lift draw 152 ft. c. to c. of channel piers, giving 140 ft. clear opening. The south channel span is a deck plate-girder swing-span, 94 ft. long end to end, giving two 35-ft. openings.

TRESTLE.—The principal particulars of the trestle construction are given by the drawing Fig. 3. The 6-pile bents carry two lines of 8 × 16 in. long-leaf yellow pine stringers under each rail, each pair being spaced by round cast-iron separator spools 2 ins. thick and held together by ¾-in. bolts. The stringers are in 25-ft. lengths, breaking joint. Two bolts were used near each end of each span. These stringers are designed for Cooper's E-40 loading, but it is contemplated to strengthen for E-50, when this becomes necessary, by adding a third line of 8 × 16 under each rail, outside the present stringers. The ties, 8 × 7 ins. by 9 ft., are spaced 14 ins. on centers; they were dressed on one side to uniform thickness, and are secured to alternate lines of stringers by ½-in. boat spikes left projecting ½-in. so as to be easily pulled by a bar for repairs. The guard-rails (outside only) are 6 × 8-in. long-leaf pine, dapped 1-in. over ties, lap-spliced and bolted with ¾-in. bolts, and fastened to alternate ties by ⅝-in. boat spikes. At intervals of 1,000 ft. refuge platforms for handcars and men are built on extended ties.

The piles are untreated cypress or long-leaf pine, of lengths varying from 55 ft. to 97 ft. They were specified to be at least 12 ins. through at a point 8 ft. below the butt, at least 7 ins. at the tip, and with at least 9 ins. heart at the cut-off. All six piles of the bent are battered. The penetration into the bottom varies from a minimum of 20 ft. to a maximum of 60 ft., averaging about 40 ft. As computed by the Engineering News formula they will sustain a load of 16 to 20 tons per pile. Cut-off level is 10 ft. 2½ ins. above mean water. Caps and braces are of long-leaf pine.

35-FT. SPANS.—The piers for the 51½ ft. girder spans are each composed of two 8-pile bents, 5 ft. c. to c. These piles were creosoted. Fig. 4 gives details of the bracing and the cap-timber system. The girders are 15 ft. c. to c. In common with the two draws they were designed at the start for E-50 loading, so that when the trestle is strengthened by adding the third stringer under each rail the whole structure will be good for E-50 trains.

ROLLING-LIFT SPAN.—The draw over the north channel is located about 9,000 ft. from the north shore. It is a square single-leaf single-track Scherzer through span of regular type. The operator's house is located alongside the track-girder piers. The trusses are spaced 17 ft. c. to c.

The piers and fenders of this span are detailed in Fig. 7. The superstructure is shown by the views Figs. 8 and 9.

The two track-girder piers are set 38 ft. 6 ins. apart, and the channel piers are 152 ft. apart, c. to c. All three are of concrete reinforced with corrugated bars. The bottom at the site of this span was so soft that to get a rigid embedment for the piles it was decided to dredge out pits at the pier sites down to firmer strata. The dredging was carried to a depth of 16 ft. below bottom, or 35 to 37 ft. below mean water.

Before starting work, a timber sheet-pile cofferdam was driven around the site of each pier. Then the enclosed space was dredged out and the foundation piles were driven. With a 2,500-lb. hammer an average penetration of 19 ft. was secured. The piles were cut off at El — 17.5, 2 to 3 ft. above original bottom, so that they projected 14 to 16 ft. above dredged bottom. Then a layer of sand about 2 ft. deep was deposited around the piles, to give a clean bed for the concrete. Upon this was placed concrete to a thickness of about 10 ft., the lower 6 ft. of 1:4:8 mixture and the remainder of 1:2½:5. The bottom thus sealed, the cofferdam was pumped out and the pier concrete placed, in forms. The main body of the pier is of 1:3:6 concrete, while the coping concrete was mixed in proportions 1:1:2.

The draw is operated by a Fairbanks-Morse 3-cylinder gasoline engine of 30 HP. At maximum speed the bridge can be raised to full height in 1¾ mins. Two engines are provided, for greater safety, and hand gear is fitted in addition.

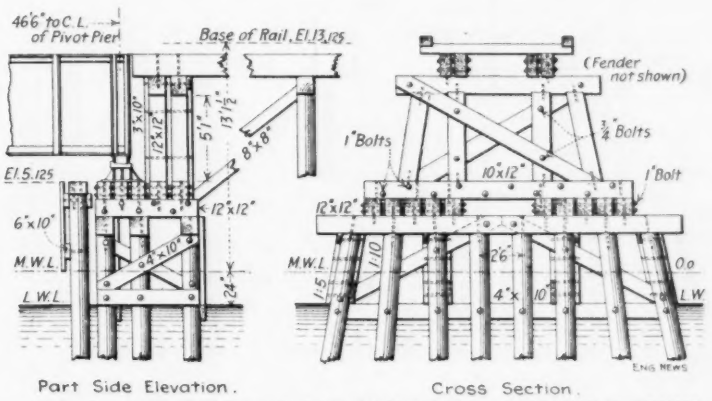

FIG. 5. PILE REST-PIER FOR SWING-SPAN, ALBEMARLE SOUND CROSSING.

SWING-SPAN.—The south channel is crossed by a 94-ft. deck plate-girder swing bridge. The center pier is a circular concrete structure 15 ft. 6 ins. in diameter, reinforced with corrugated bars. The same method of construction was followed as for the Scherzer span piers, but the excavation was not as deep. The turntable is 13½ ft. in diameter, and the girders of the bridge are set 6½ ft. c. to c.

The rest-piers of this span consist each of three 8-pile bents braced together. Fig. 5 shows this construction more fully. Fender piling protects each rest-pier, and the center pier has a timber dolphin 86 ft. long, one end of which also carries the bridge-tender's house. A cluster of 16 piles guards each end of the dolphin.

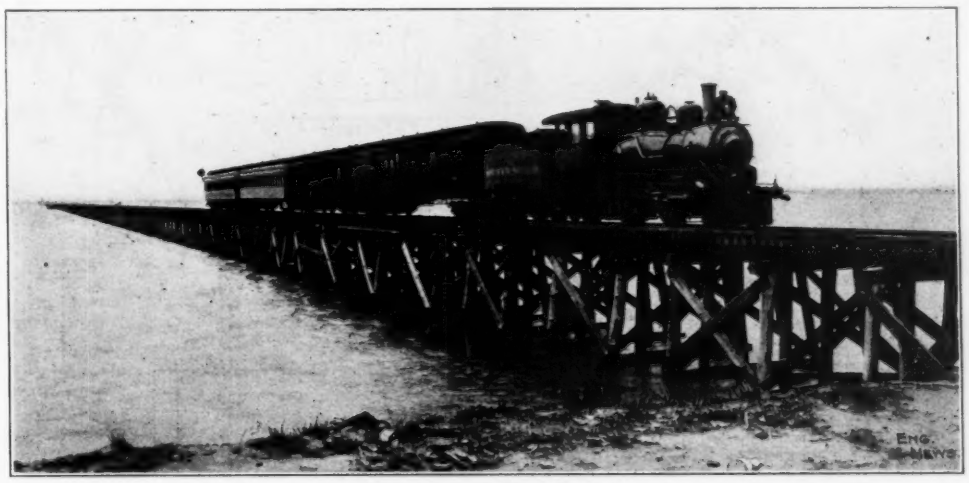

FIG. 6. VIEW OF NORTH END OF ALBEMARLE SOUND TRESTLE OF NORFOLK & SOUTHERN RY.

The crossing was designed under Mr. F. L. Nicholson, Chief Engineer of the Norfolk & Southern Ry. Mr. J. E. Greiner, of Baltimore, Md., was Consulting Engineer. The company's Resident Engineers were Messrs. Philip Aylett, R. W. Kennison and D. B. Packard. The trestle was built by the McLean Contracting Co., Baltimore. The concrete piers were built by the

McDermott Contracting Co., of Philadelphia. The steel spans were fabricated and erected by the Pennsylvania Steel Co., of Steelton, Pa.

Construction work was begun July 20, 1907, but in November of the same year it was suspended on account of the financial stringency, remaining idle for over a year. Work was resumed on February 20, 1909. A train carrying

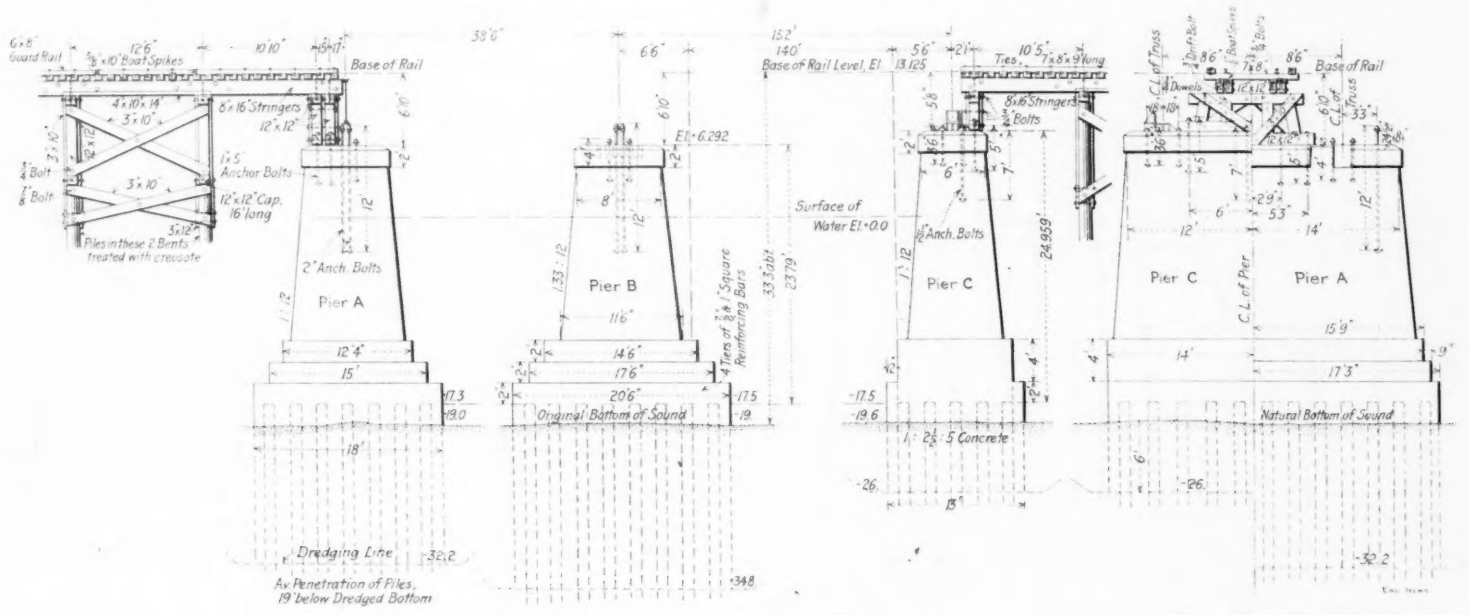

FIG. 7. ROLLING-LIFT SPAN, PIERS, FENDER PILING AND TRESTLE CONNECTION.

officers of the road was run over the completed structure on Jan. 1, 1910, and on Jan. 17 the crossing was opened for traffic.

The bridge saves an hour in time for passenger trains, and some 6 to 12 hours for freight trains, in addition to eliminating the operating cost of the ferry.

How to Keep an English Patent Alive.

By AN ENGLISH LAWYER.

American inventors who have obtained protection for their inventions within the United Kingdom must needs take care that, by reason of a comparatively recent change in English Patent Law, these rights are not allowed to lapse. To retain their monopoly in England they must work their inventions in England, either by themselves manufacturing, or else by granting licenses freely to other persons to manufacture.

It is not proposed to be highly technical in this article: suffice it to refer to section 27 of the English Patents Act, 1907, which provides that:

> Any person may apply to the Comptroller for the revocation of the patent on the ground that the patented article or process is manufactured or carried on exclusively or mainly outside the United Kingdom.

Under this section an American, who was a rival in business of another American who had taken out a patent in England, might apply to have that patent revoked if it was not worked in England. This shows that an English patent which is allowed to lie dormant, is a very vulnerable commodity.

It is proposed, in this article, to indicate some of the most convenient methods by which a person foreign to England may comply with the law. Of course he may work his patent himself, when no question arises, but he more often finds it convenient to grant licenses to other people.

Licenses.

Mr. Roberts in his "Patents and Designs Act, 1907," page 65, says that:

> "Although the fact that the patentee has offered to grant licenses will not be an answer to a charge of non-working, it may substantially assist, or its absence may substantially prejudice, the patentee in showing that the process is worked to an adequate extent in the United Kingdom, or in proving satisfactory reasons why it is not worked."

However this may be, it is obvious that many foreign owners of English patents who cannot afford to erect works in Great Britain will have to resort to the device of authorizing persons in England to work and manufacture in order to escape the penalties imposed by the Act of 1907. In these circumstances it is probable that many English manufacturers will soon be tempted to become licensees of patents hitherto worked abroad. A few notes upon that branch of the patent law which relates to licenses may therefore be of some practical use to American manufacturers.

A patent license may be either a bare license (in which case, whether it is exclusive or not, it may be revoked at any time) or it may be a license coupled with an interest in the invention to which it relates. In the latter case it cannot be revoked. To illustrate what is meant by a license coupled with an interest, reference may be made to the case of Ward vs. Livesey (5 Reports of Patent Cases, England, 105). There the license was an authority enabling the licensees not merely to make the patented articles, but also to sell them when made to any person they chose and at whatever price they liked. This was held to be a license coupled with a grant.

It is not necessary that a license shall be composed by deed. It has been held by the House of Lords that a license given by a verbal agreement merely is valid, and that the persons so

licensed were estopped from denying the validity of the licensor's patent.

That, however, is the letter of the law. In practice no one should take a license without having all its terms carefully considered and

FIG. 8. ROLLING-LIFT DRAW, LOOKING SOUTH.

reduced to writing. During the negotiations, the parties may foresee no difficulties; but when something troublesome turns up it is always satisfactory to find that it has been anticipated and provided for.

It may be mentioned that the following points are generally insisted on by anyone who is about to take a license. The licensor should be prepared to give, and the licensee insists upon having, an undertaking by the licensor that he will take all needful steps to prevent infringement of the patent. In addition to this a licensee often takes a guarantee that the patent is valid. It may be worth while for a prospective licensor to remember that the license does not of itself impose upon the licensee any liability to make or vend the particular article. So long as the license continues the licensee cannot dispute the title of the licensor. Even if the patent is found invalid, this is no defense to an action for royalties under the license. To avoid any such absurd result, the licensee generally sees that there is a clear provision inserted for the termination of his obligation to pay royalty upon the patent being adjudged invalid, unless the decision is reversed on appeal.

The non-payment of royalty is usually made a cause for forfeiting the license. In the interest of the licensee, the payment of royalty is sometimes made conditional upon the subsistence of the patent, but the licensor would be well advised not to tie himself down to any such provision.

In certain sections of the Act of 1907, it is declared to be unlawful in any contract in relation to the sale or lease of, or license to use or work, any article or process protected by a patent to insert a condition the effect of which will be: (a) to prohibit or restrict the purchaser, lessee, or licensee from using any article or class of articles, whether patented or not, or any patented process, supplied or owned by any person other than the seller, lessor, or licensor, or his nominees; or (b) to require the purchaser, lessee or licensee to acquire from the seller, lessor or licensor, or his nominees, any article or class of articles not protected by the patent. This provision does not, however, apply if (1) the seller, lessor or licensor proves that, at the time the contract was entered into, the purchaser, lessee or licensee had the option of purchasing the article or obtaining a lease or license on reasonable terms without the objectionable conditions referred to; and (2) if the contract entitles the purchaser, lessee or licensee to relieve himself of his liability to observe any such condition on giving three months' notice in writing and on payment in compensation for such relief of such sum or such rent and royalty as may be fixed by an arbitrator appointed by the Board of Trade.

Inasmuch as this branch of the law has only been in force for a short time, it has not yet been the subject of judicial explanation.

Assignments.

The rights of a foreign patentee can also be secured by assignment of the right to work the patent in England.

A patentee may make an absolute assignment of his patent rights for the United Kingdom, so that, apart from express restriction, the assignee would have a perfectly independent right to work the invention, to grant licenses, and to sue for infringement in this country. Mr. Swan, in his "Patents, Designs and Trade Marks" draws attention to the following points for the guidance of a person about to take an assignment.

A purchaser should consider the advisability of inserting in the deed of assignment provisions to the following effect:

(1) That the vendor will instruct the purchaser in the working of the invention, and afford him such information and assistance as may be necessary to enable him to carry out the invention to the best advantage.

(2) That the vendor—if he is the inventor—will keep the purchaser informed of all improvements he may make during the term of the patent, and, at the purchaser's request, assign to him the benefit of such improvements.

(3) That the vendor will refrain from engaging in or fostering any work antagonistic or prejudicial to the success of the invention sold.

It is hoped that the observations which we have made above may be of assistance to American inventors who own patents in England, and who for the purpose of keeping those patents alive are constrained to enter into arrangements with English manufacturers.

DUST PREVENTION BY SPRINKLING with calcium chloride is criticized by the Roads Improvement Association of England. A committee of road engineers appointed by the association to examine various sections of road which had been sprinkled with calcium chloride solution to lay dust has just rendered a report. The committee says that the treatment has the ill effect of causing, during the winter months, an abnormal quantity of sticky mud, a decided tendency to licking up, and a disintegrating action upon the macadam surface. Nevertheless the committee concludes that the calcium chloride solution is probably not more injurious to the macadam roads than the excessive water now demanded by the public in order to keep the dust down.

FIG. 9. THE ROLLING-LIFT DRAW IN OPEN POSITION.

Tests of Simple and Inexpensive Surveying Instruments.*

By JOHN T. STEWART,† Assoc. M. Am. Soc. C. E.

Agricultural bulletins and instrument catalogs describe from time to time various simple and inexpensive devices and instruments for performing survey work. The demand for such apparatus usually comes from agriculturists or mechanics who have not had engineering training. Neither have they sufficient work to justify the purchase of the ordinary grade of engineer's instruments. The work on which such instruments is to be used is not of sufficient importance or magnitude to justify the employment of an engineer unless one should be near at hand. In many of our agricultural districts an engineer is not available except by the expenditure of considerable money for traveling expense and time. Unless this work is of considerable magnitude an engineer is not employed and agricultural improvements are carried on by such methods as the ingenuity of the workman may happen to devise.

Consequently there is apparently a field for an instrument that can be used by a person of ordinary mechanical ability; something between the range of the carpenters' level and square and the engineer's level and transit. The writer has had inquiries at various times for advice in regard to such an instrument. On examining into this subject he was not able to secure any definite data. Engineers who are competent to pass judgment on such devices use first-class instruments and have no time to experiment with second-class ones. Information in regard to second-class instruments or home-made devices simply state that such an instrument was used for a certain purpose and cost so much, there being no data given to indicate the range, efficiency and accuracy. Hence it appeared desirable that these various devices should be tested by one person under the same conditions, and that a study might be made of each, having in view its use by persons unskilled in surveying.

This test work was carried on during the summer of 1909 under the direction of the writer, at the University Farm, St. Paul, Minn., as part of the agricultural experimental work by the Division of Agricultural Engineering. The actual testing was done by Mr. H. B. Roe, a regular employee of the division, who had had ten years' experience in railway engineering work, assisted by Mr. Geo. F. Krogh, who is also a regular employee of the division as draftsman and general field assistant. All the field work and compilation of results was done by these two men, the object being to test each instrument in skilled hands and under the best conditions, and from that information determine its value under less favorable conditions. The land selected for the test was neither entirely level nor extremely hilly, but presented such topographic features as would ordinarily be found on farms where there would be a demand for this class of work.

In carrying out these experiments the following points of comparison have been kept continually in mind: (A) construction; (B) first cost; (C) simplicity of operation or knowledge necessary to adjust and operate; (D) the reach or range of sight and the consequent rapidity of work; (E) retentivity of adjustments under varying conditions of handling and weather; (F) results and remarks. For convenience each instrument tested is numbered and referred to by its number, the object being to determine the value of the general pattern of the instrument rather than the individual make of any special pattern.

In the elevation tests, readings were all taken on hubs, an engineer's 20-in. Y-level being used as a standard. Whenever a defect was detected in an instrument which was liable to be intensified by conditions of weather or change of ground, a special test was carried on under these conditions to determine their actual influence. The reach of the standard level was 500 ft. each way, or 1,000 ft. at a set up; with a self-reading rod, 1,320 ft. at each set up, ½ mile being covered with a self-reading rod in 30 mins.

No. 1 (Straight-Edge).—This was an ordinary straight edge 12½ ft. long, having a 30-in. leg on each end to raise the main part above the ground so that grass, rough ground, etc., between the stakes would not interfere with setting it. It is leveled by an ordinary carpenter's level attached to the upper side with a clamp. Complete cost: Carpenter's level, 75 cts.; wooden rod, $1; material in frame, $1.25; labor in making frame, $2.75; total, $5.75.

The adjustment and method of using are the same as with the carpenter's level. The reach at each set-up is 12½ ft., ½-mile covered in 3 hrs. 5 mins.

Retentivity of adjustment was very poor, as variable humidity and windy weather made almost continuous adjusting necessary, due to warping and twisting. The results obtained by the use of this instrument were so unreliable that it can be of no use in survey work where levels are carried any distance when any degree of accuracy is desired. It is unwieldy in windy weather and the adjustments are rendered unstable by warping and twisting.

No. 2 (Triangle).—This instrument is a wooden triangle having a reach of 12½ ft. and is set level by a carpenter's level attached to a cross-bar with a clamp. Complete cost: Carpenter's level, 75 cts.; material in triangle, $1.50; labor making triangle, $4.24; total, $6.50.

Adjustment and method of using are the same as with the carpenter's level. The reach at each set-up is 12½ ft., ½-mile covered in 2 hrs. 20 mins.

Retentivity of adjustments was good, as they were not affected by weather changes. A triangle can be used to good advantage for preliminary levels when time is not an object. While the errors were somewhat variable the general results were fair. However, too much reliance should not be placed on it for setting long lines of grade stakes where great accuracy is required.

The same 30-in. standard carpenter's level was used on both Nos. 1 and 2. The bubble was too slow for accuracy when used in running long lines. A small level put up in a metallic case so constructed that it can be attached to a carpenter's square was tried, but it was worthless on account of the slow bubble.

No. 3 (Hose with Glass Tubes).—This outfit consisted of 25 ft. of a good grade of ¾-in. garden hose with a glass tube fastened in a 4-ft. length of hose coupled to each end. Complete cost: 25-ft. hose, $3.75; 8-ft. hose in 4-ft. lengths, $1.20; 2 couplings, 20 cts.; 2 glass tubes 18 ins. long, 20 cts.; 2 graduated rods, $2; total, $7.25.

There were no adjustments. The reach was 25 ft. at each set up; ½-mile covered in 2 hrs. 20 mins.

It was sensitive to variation in temperature; as the water grows warm in the hose results become more unreliable, especially on sloping ground, the tendency being to run the elevation low. Where water is kept cool, either by using the instrument morning and evening, by frequent changes of water, or by working in cold weather, this instrument is simple, reliable and convenient. A 50-ft. length of hose was tried, ½-mile being covered in 1 hr. 10 mins., but it was so heavy to drag that it was very tiring on the operators and caused the hose to wear. The errors due to varying temperature in the water were also increased.

No. 4 (Carpenter's Level with Sights).— This was the same carpenter's level that was used with Nos. 1 and 2, but fitted with the peep sights carried in stock for carpenter's levels and then mounted on a home-made tripod. Complete cost: Carpenter's level, 75 cts.; sights, 50 cts.; labor and material of making tripod, $9.75; flexible rod 6 ft. long, $1.50; total, $12.50.

It requires practically the same knowledge for adjustments and operation as is required for the engineer's Y-level. The reach with a self-reading rod is 75 ft. each way or 150 ft. at a set-up; with a target rod, 200 ft. at a set-up. With a self-reading rod, ½-mile covered in 2 hrs. 15 mins.

Retentivity of adjustments was good. The results were very good. A better bubble in the carpenter's level would make this a very practical instrument.

No. 5 (Sighting Tube).—This was a factory-made instrument with a 1-in. sighting tube 10 ins. long, having a plain glass in place of an objective and a pin hole for an eye piece; it was mounted on a tripod. Complete cost, including a 6-ft. flexible rod, $16.

This requires the same knowledge for adjusting and using as the engineer's dumpy level. The reach with self-reading rod is 75 ft. each way, or 150 ft. at a set-up. With target rod, 200 ft. at a set-up. The ½-mile was covered with a self-reading rod in 1 hr. 15 mins.

Retentivity of adjustment is good, but very slow to adjust when adjustment is required. This instrument, as it came from the factory, had too large a pin hole in the eye plate and too coarse a cross hair. Tests showed it to be impossible to adjust closely or to obtain anything approaching accurate results. After the pin hole and cross wire were reduced to half the size good results were obtained. The elevations varied slightly from that of the Y-level. The bubble, however, was too slow.

No. 6 (Small Dumpy Level).—This was a small factory-made dumpy level with a 10-in. telescope and 1-in. objective glass, mounted on a tripod. Complete cost, including a 6-ft. flexible rod, $25. It requires the same knowledge to adjust and operate as the engineer's dumpy level.

Reach with self-reading rod, 400 ft. each way, or 800 ft. at a set-up. With target rod, 1,000 ft. at a set-up. The ½-mile was covered with a self-reading rod in 45 mins. Adjustments unreliable. This is a well put-up instrument with the exception of a slow bubble and no focusing screws. It gave fairly good results, but the slow bubble caused occasional variation.

No. 7 (Telescope and Leveling Plate).—This was a factory-made instrument consisting of a telescope passing through a metal disc which rests upon a circular plate. The bubble is placed parallel to the telescope in the top of the disk, the plate resting on the leveling screws The disk and plate are not fastened to the tripod head and must be taken off and carried in the hand when moving from one station to another. Cost, including a folding wooden rod 10 ft. long, $15.

This requires the same knowledge to adjust and operate as the engineer's dumpy level. Reach with self-reading rod, 300 ft. each way, or 600 ft. at a set-up; with target rod, 700 ft. at a set-up. The ½-mile was covered with a self-reading rod in 1 hr. 30 mins. Retentivity of adjustments is fair.

This instrument compares favorably with the engineer's level, but there was a tendency to run high. This was probably due to the coarse, irregular cross hairs and the construction of the leveling disk, which had a tendency to rise or fall in correcting slight deviations of the bubble as the telescope rotated on its vertical axis.

No. 8 (Telescope in Box).—This instrument has a telescope 9 ins. long, with a ⅝-in. objective, placed in a rectangular metal box 7½ ins. long and 2¼ ins. wide, the leveling bubble being placed in the upper side of the box. The instrument is attached to a tripod by means of a ball and socket joint with a leveling plate. Complete cost: Instrument, $30; 6-ft. folding leveling rod, $1.50; total, $31.50.

It requires the same knowledge to operate as the engineer's level. It is very hard to adjust, as it has no capstan screws and there is no provision for making the horizontal cross hair horizontal except when the instrument is manufactured. In the instrument tested this hair was not horizontal.

The reach with self-reading rod is 400 ft. each way, or 800 ft. at a set-up. With target rod, 1,000 ft. at a set-up. With a self-reading rod, ½-mile was covered in 1 hr. While this instrument is intended to be simple, it is really complicated, with no particular advantages. It did very good work in skilled hands but undoubtedly would be a failure in the hands of an amateur.

No. 9 (Architect's Dumpy Level).—This was a small factory-made level listed as an architect's dumpy level. It has an 11-in. telescope with a 1⅛-in. objective, being constructed the same as an engineer's dumpy level. Complete cost: Instrument, $45; flexible rod, $1.50; total, $46.50.

No. 10 (Convertible Y-Level).—This was a factory-made instrument listed as an architect's convertible Y-level. It is a combination level and transit. It can be set up as a Y-level, and the telescope can be taken out of the Y's. The detachable horizontal axis screws into the sides of the telescope and when placed in the Ys it can be used the same as a transit. Complete cost: Instrument, $75; flexible rod, $1.50; total, $76.50.

The following applies to Nos. 9, 10 and 11 (the last being an "architect's Y-level." Each requires the same knowledge to adjust and operate as an engineer's level. Reach with self-reading rod, 400 ft. each way or 800 ft. at a set-up; with a target rod, 1,000 ft. at a set-up. The ½-mile was covered with a self-reading rod in one hour. The retentivity of adjustments is as good as with the engineer's level. The plan and construction of these instruments is the same as the standard engineer's instruments, but they are smaller and lighter, consequently their range is somewhat less. The sensitiveness of the bubbles is well suited to the magnifying power of the lenses.

While these tests were primarily made to determine the value of each instrument as a level, some of the instruments were arranged for the approximate measurement of angles. Consequently, an area was laid out and the angles measured with such instruments as had a compass or circle attachment. An engineer's plain surveying transit was used as a standard.

No. 5. A circle 3¼-ins. diameter, graduated in degrees, was under the telescope. A metal arm attached to the spindle moved on the inner side of this circle and revolved with the telescope. No. 6 had practically the same angle attachment. In No. 7, the 4-in. metal disk had a zero line on one side, and revolved on the inner surface of the plate, which was graduated in degrees. In No. 8, a 3-in. compass was attached to the top of the box. In No. 10, a 3-in. compass was inside the circle on the bar which carried the Y's while on the outside and beneath the bar was a vernier which moved on a 3½-in. circle divided into degrees. In No. 11 (architect's Y-level), the bar which carried the Y's, had underneath it a 3-in. circle graduated in degrees. The sides of the bar were curved outward in a circle, and one of the sides carried a vernier which moved on the upper surface of the circle.

Summary of Factory Instruments.—None of the factory-made instruments were entirely satisfactory, until No. 9 (the architect's dumpy level) was reached. This seems to be the cheapest instrument that can be really depended on. Such an instrument, including a satisfactory rod, would cost $41. If it is desirable to have an instrument that can be used for measuring angles, it then becomes necessary to get the architect's Y-level No. 11. This instrument, with the same rod as above, would cost $51.

All of the factory instruments preceding No. 9 were unsatisfactory or faulty in some respect, as in the effort to meet the demand for cheap instruments the instrument makers have turned out crudely made instruments,

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not thoroughly tested. Too much care has been taken to secure a good telescope, without proper regard to the cross hairs and sensitiveness of the bubble. The fact that the accuracy of the leveling instrument is dependent on the bubble rather than the magnifying powers of the telescope seems to have been overlooked. All of these cheaper instruments have very light tripods, and the rods that come with them are only makeshifts and of little value, being either poorly made or too short for actual service.

Conclusions.—From the experiments the following conclusions can be drawn. The small levels usually carried in stock by hardware men are worthless when used as bubbles on crude surveying instruments. The bubble of the ordinary carpenter's level is not of sufficient sensitiveness to insure at all times good results when used on an instrument for running long lines.

The straight edge is not satisfactory as a surveying instrument.

A triangle is of considerable value where great accuracy is not required. Its efficiency could be considerably increased by using a better grade of bubble than comes in the ordinary carpenter's level.

The 25-ft. length of hose is the best instrument for the inexperienced person to use. Its accuracy is good when the conditions named under No. 3 are observed. There is only a small outlay in the initial cost, for garden hose can be used for other farm purposes.

The smallest sum that can be invested in an outfit that will be reliable and give satisfactory results is $41 for an equipment which will not measure angles, or $51 for an equipment that will measure angles. The knowledge to adjust and operate them would require a general knowledge of the engineer's level.

Where it is not possible to invest in the cost of instruments 9 and 11, and something more convenient than the hose is desired, a carpenter's level fitted with sights, having a bubble just a little better than ordinarily comes in such a tool, and mounted on a home-made tripod, will give better results than the cheaper factory-made instruments of a corresponding price. Such an equipment ought to be fitted out at a cost not to exceed $15 for the instrument, while the cost of a suitable rod (which should be the same as for Nos. 9 and 11) would bring the total price of the outfit up to $21. Such an instrument would be more stable when set up and would stand more rough usage than any of the factory instruments tested preceding No. 9. When not in use as a surveying instrument, the level could be used as a carpenter's level.

Any of the instruments give satisfactory results in angle work for farm surveys where the boundary lines are established.

High Speed Steel and Its Heat Treatment.*

By W. G. SMITH, M. E.†

There are four distinct eras in the history of tool steel:

(1) Carbon Steel—up to 1894.
(2) Self-hardening Steel—1894—1900.
(3) Experimental Era of High Speed Steel—1898—1905.
(4) High Speed Steel Era—1905——.

Carbon Tool Steel, as its name indicates, is chiefly an alloy of carbon (from about 0.5% to 1.5%) and iron. Slight percentages of silicon, manganese, sulphur, and phosphorus are also found in the mixture, silicon and manganese being useful constituents, giving improved fusing and working qualities, together with increased ductility and resistance to shocks, provided the percentage is correct. Sulphur and phosphorus are impurities, and affect the toughness of the material, phosphorus tending to make the steel "cold short" (brittle), and sulphur making it "red short" (difficult to forge). These impurities must be kept at the lowest commercially possible amount.

Carbon Steel, by heating to a cherry red and then suddenly cooling (quenching), takes on a quality of extreme hardness, due to the presence of carbon, and in proportion to its amount. It has the quality of brittleness, which is lessened by adding limited amounts of silicon and manganese. Forging is difficult, and cannot be accomplished at a greater heat than cherry red. The hardened tool will not stand a heavy duty, because the frictional heat so generated will soften the tool. Thus the scope of the tool is limited. Its cutting speed on mild steel, taking off a light chip, is about 25 ft. per minute under good conditions of hardening and homogeneity of structure, less than that under ordinary conditions.

Self-hardening steel was discovered 30 years before it came into anything like common use. Robert Mushet discovered it between 1860 and 1870. He found, by adding tungsten and chromium instead of manganese, that a tool was hard when slowly cooled after forging. That is, the tool required no extra heating to harden it after it had been forged. A carbon-steel tool has no "edge" after forging, the slow cooling making it "annealed" (soft); but this new steel was already hard, and required only grinding. This steel was expensive, however, and for many years was only regarded as a fad. In the early 90's it was found that it would accomplish 45% more work on hard forgings, etc., than the carbon steel would do. But it was not adopted in many shops for cutting soft metals, until it was found that it would cut 90% more than the carbon steel. This steel was really a high-speed steel, but its proper heat treatment had not been discovered.

HIGH-SPEED TOOL STEEL.—Up to 1898 it was universally supposed that steel was hopelessly ruined when heated to the "breaking down" point. This point is 1550° F. (cherry red), and tool steel was never allowed to be heated beyond that point either in forging or hardening. That year Messrs. Taylor and White were conducting experiments for the Bethlehem Steel Works, and accidentally discovered that there was a limit to the "breaking down" range, and that after passing 1700° F., tungsten steel regained the power of hardening, and further, that if it were heated to 2000° F. or up to 2200° F., it possessed the quality of "red hardness," that is, not losing its hardness when heated red.

This was a startling and revolutionary discovery, and upset all theory on the subject, opening an immense field for scientific research and commercial adaptation. Additional tungsten and chromium were used up to the point of saturation, and various substitutes were tried, such as molybdenum, vanadium, and nickel, and the result is the modern high-speed steel.

The perfection of high-speed steel has already brought about wonderful changes in machine design, in economy of production, in increased wages, and in the equipment of new shops. The production of a machine is vastly increased by using the new tools, and therefore it is not necessary to install as much machinery as was formerly the case. The tools, being capable of so much more work without injury, enable the workman to use his tools constantly without the trouble of re-hardening and frequent sharpenings.

WHAT MAKES STEEL HARD?—Unquestionably it is the carbon content, as the hardness is found to vary directly with the amount of carbon. Upon heating an alloy of iron and carbon to certain temperatures, and then cooling slowly or rapidly, we find many differing molecular structures, which have certain characteristics—crystalline, fibrous, dark, light, uniform, irregular, or showing streaks, spots, polyhedra, and other differences in the section. Each of these structures is characteristic of a certain grade of steel, and in fact is an individual metal in itself. They have been classified by scientists and are given names, such as pearlite, carbide, martensite, troosite, austenite, cementite, sorbite, etc.

Most of these metals are worthless for cutting tools. They may be flint hard, but have no resistance to abrasion or heating, or they may be brittle. It is the metal "carbide" that is the useful one. In this alloy the carbon is thoroughly and uniformly united with the iron, its fracture is clean, and its hardness is intense. Unless this carbon can be kept suspended in solution, it softens on heating. Here is where ordinary tool steel fails. A comparatively low heat, caused by the friction of the chip, or by other means, will segregate the carbon, and change the structure to one of the useless metals, martensite or troosite. The addition of tungsten and chromium prevent this disintegration, and give the high speed steel the qualities which distinguish it.

INFLUENCE OF CARBON.—Carbon is essentially a hardening agent. It increases the tensile strength and introduces a quality of brittleness. The brittleness is greatly increased in the supersaturated steels. It is found that steel is saturated (though there is contention over this) when 0.89% of carbon is present. The greatest range of efficiency agreed on by all investigators, is 0.4% to 0.9%. Such steels are hard and comparatively tough. With more than this amount of carbon, the steels are not desirable, being difficult to forge, and the tools are inferior. Increasing the carbon renders the steel liable to break under unequal and intermittent cutting.

INFLUENCE OF CHROMIUM.—The next important step is to ascertain the influence of chromium in amounts from 1 to 6%. Steels having a low percentage are very tough and perform excellent work on the softer varieties of cast iron and steel, but on harder materials the results are not as efficient. By increasing the chromium the steel becomes harder and has greater efficiency on hard materials. It is noted that with the increase of chromium there must be a decrease in carbon to obtain the best results.

Vanadium has been substituted for chromium and gave good results in the same way, but no better than the much cheaper chromium.

INFLUENCE OF TUNGSTEN.—Gledhill, of Armstrong & Whitworth (England), made experiments using tungsten up to 27%. With from 9 to 16% of tungsten, the nature of steel becomes very brittle, but its cutting efficiency is greatly increased. Beyond 16% the results were no better. From 18 up to 27%, the nature of the steel altered somewhat, and, instead of being brittle, became softer and tougher, and while such tools have the property of cutting very cleanly, they do not stand up well. My opinion on this point is that the correct amounts of carbon, silicon, and chromium offset this softness and compensate in the matter of cutting and wearing. The addition of the small amount of vanadium, which is found in the Taylor-White formula, undoubtedly exercises a very beneficial effect here. Tungsten is the restraining agent that prevents the carbon from segregation under violent heat. Böhler states that tungsten lowers the fusion point of steel.

INFLUENCE OF MOLYBDENUM.—This element is rarer and therefore more expensive than tungsten, and its worth, as far as I can determine, is yet to be decided. As a rule it is an excellent ingredient in high-speed steel, and possesses the qualities of tungsten in an intensified degree. A small percentage of molybdenum will accomplish the same results that four times that amount of tungsten will do. It has this peculiarity: Molybdenum steels do not require as high a temperature for hardening to obtain the greatest efficiency, and if tools are heated above 1832° F. (1000° C.), they are inferior and shorter lived. Combining molybdenum with tungsten gives good results in cutting efficiency, but probably the advantage (if any) is not enough to justify the increased cost.

INFLUENCE OF SILICON.—Silicon in limited quantities increases the cutting efficiency of high-speed steels, sensibly increasing their hardness. By exceeding 3% of silicon the cutting efficiency declines.

Other metals, nickel, vanadium, titanium, etc., have been experimented with, but the results do not seem to justify using them. Vanadium is found in the formulas of some good high-speed steels in small amounts.

The Taylor-White formula for 1907 is:

Carbon	0.67%
Chromium	5.47%
Tungsten	18.91%
Manganese	0.11%
Vanadium	0.29%
Silicon	0.043%

As before stated, more tungsten is now used.

As an instance of the necessity for careful treatment of the steel, Brayshaw maintains that a difference of one degree Centigrade in heating steels makes a difference in hardening, and that five degrees Centigrade (nine degrees Fahr.) constitutes the difference between good and bad hardening. In view of the high heat required for hardening high speed steel (2,300° F.) this scarcely seems reasonable. Average practice probably does not do better than to keep the variation down to less than 10° C. (18° Fahr.). It is doubtful whether the human eye can keep it closer to the standard than this. My opinion is that a variation of 100° F. is not serious and that any heat between 2,200° F. and 2,300° F. will give first class results.

FORGING.—The shaping of the tool under the hammer or press must be done at a yellow heat, 1,900° F., and when it falls to 1,750° F. (bright red), it should be reheated before further hammering. Any forging done at a lower heat will result in cracks and splintering that will ruin the tool.

HARDENING.—Tools and implements are too soft, as they come from the forge. Hardening is accomplished by heating to temperatures which vary in accordance with the carbon content, and then cooling suddenly by immersion in a bath of air, water, oil, lead, etc. Slow cooling will also harden high speed steels.

TEMPERING.—When cooled suddenly, steel is sometimes too brittle for most cutting purposes, and this quality of brittleness is removed or modified by reheating to temperatures varying between 400° F. and 600° F. The higher it is reheated within these temperatures the softer it becomes, and this reheating for toughening and partially softening tools is called "tempering."

DIFFICULTIES OF HARDENING.—(a) Each tool, depending on its chemical composition, has a peculiar temperature at which a radical change in the condition of its carbon takes place. This temperature is called variously the "critical point," "refining point," and "point of recalescence." In order to obtain the best results the steel must be heated uniformly to a temperature slightly above this point. Otherwise it fails to harden on quenching. If the heating is carried much above the critical point the grain is coarser and there is increased weakness and brittleness after quenching.

(b) The lack of uniformity in heating causes internal strains, and causes cracks to set up on cooling.

(c) It is difficult to cool properly. Uneven or irregular cooling produces severe internal strains called water cracks.

From the foregoing it will be seen that it takes skill and judgment in treatment to bring about the necessary combination of toughness and hardness.

THE BARIUM-CHLORIDE PROCESS.—For hardening fine tools that must retain their cutting edge and size, as, for instance, taps and milling cutters, there is no process, in my opinion, equal to the "barium bath." Fine tools cannot be made as well, if they are made oversized and then ground down. But if a scale of oxide is formed on the tool, it has to be ground down. Packing in muffles and other devices, such as the electrical method, help, but do not entirely overcome the difficulty, and some are troublesome. The lead bath has been

*Extracts from an article in "The Armour Engineer."
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tried, but does not answer for high-speed tools, although it is reasonably satisfactory for carbon steels.

Lead can be raised to the required temperature, but a scum of lead oxide obscures the appearance of the bath, and tools will float unless held down. Moreover, the tool oxidizes in passing from the heating bath to the quenching bath, and in delicate tools this is sufficient to ruin them.

The bath of barium chloride was first used in Germany to replace the lead bath. It is now used in this country by many firms, and is found to be satisfactory. A crucible large enough to hold a barrel or so of barium chloride is placed over a foundation of fire brick with plenty of holes for the circulation of flames. The gas has a rotary motion about the crucible and heats it from all sides. Above the crucible is a hood to draw off the fumes, etc. The barium chloride salt is placed in the crucible and raised to 2,200° F. This is easily gaged and maintained by connecting the bath with a pyrometer, of which there are several inexpensive makes. The disagreeable chloride fumes can be kept at a minimum by adding a handful of sodium carbonate (soda ash). Care must be taken to avoid adding too much, as it renders it impossible to raise the solution to the desired temperature.

When the bath is heated to 2,200° F. (some steel men urge 2,300° F. as the best temperature), which is a white heat, place the tool in the bath, and let it soak until it is raised to the temperature of the bath. Let the tool remain for a few minutes until it is thoroughly heated, for one of the essentials to good hardening is thorough heating. In the case of taps, where the cutting edges are required to be very hard, with a relatively soft body, the tool is not left long enough to heat anything but the edges to the highest point. If large tools are to be hardened, they should be preheated to a low red in a muffle, so as to prevent cooling the barium bath on immersion. The addition of a large piece of cold metal lowers the temperature of the bath considerably.

QUENCHING.—Air quenching is perfect for this process because the coating of barium chloride on the tool prevents oxidation upon removal from the bath. An air blast is expensive, costing 60 cts. an hour to maintain a 60-lb. pressure on a 4-in. blower. When tools are cooled by air they are laid in a wooden trough and the blast from the blower passes over them. An oil bath is more economical, as there is practically no loss of oil, and the first cost is about all there is of it. After the tool has been heated thoroughly and uniformly, and is left a few minutes (never over ten minutes) in the barium bath so as to unify the metal, the tool is removed and immediately plunged in the air or oil bath. Tools with delicate edges require tempering after this. The tanks with their proper heating arrangements and appliances for handling the work may be purchased outright, and it is hardly necessary to describe them in this article.

After the coating of barium scale has been brushed off the tool, it is found to be of its original size, and of very much the same appearance as before heating. Under ordinary processes of hardening and tempering the tool takes on a blue or brown color, according to the method. In this process, however, the color is unchanged because there is no chemical action on the steel, the coating of barium chloride acting as a shield against any oxidation. Many workmen are amazed at the appearance of the tool and refuse to believe that it has been hardened at all.

SUMMARY.—High speed steel must not be regarded as an extraordinarily hard steel. The old style of carbon steel was fully as hard, but the new steel possesses the property of holding its hardness under duty that would immediately ruin a carbon steel tool.

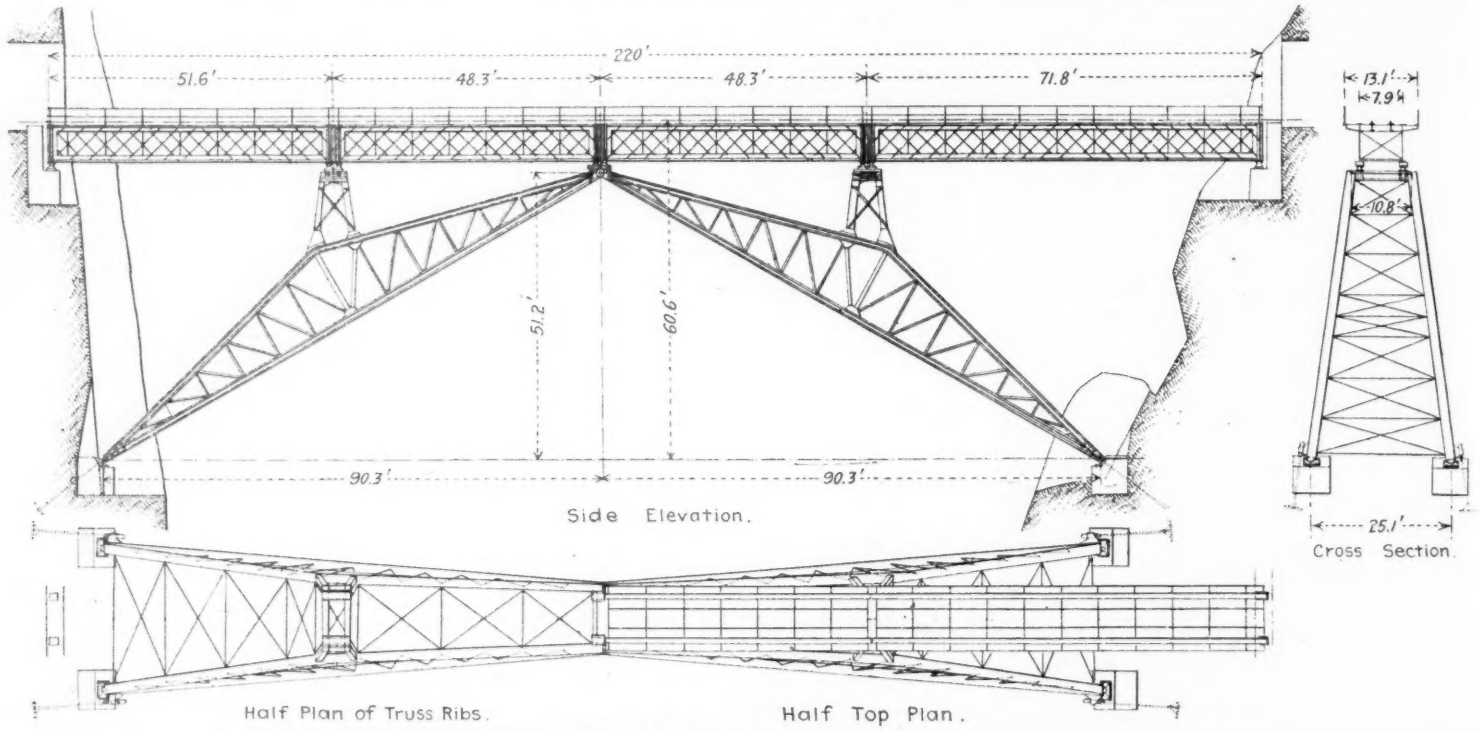


FIG. 1. GENERAL ELEVATION AND PLAN OF ARCH ACROSS NAM-TI GORGE, FRENCH CHINA.

A Steel Arch Bridge in the Province of Yun-Nan, French China.*

In the French provinces of China there is now in course of construction, between the frontier village of Lao-Kay and the interior city Yun-Nan-Sen, a railway under the direction of French capitalists and French engineers. The climate, the conditions of transportation and the very poor quality of the workmen have made the construction of this road subject to a number of difficulties which force the engineers to carry on their work in the simplest fashion possible. On the other hand, the topography of the country is extremely rugged, so that in a number of instances gorges had to be crossed, which under ordinary conditions would require rather complicated structures. In such cases, it became necessary to design bridges which could be easily built by the poor labor available. At one place, in particular, the gorge at Nam-Ti, a unique type of bridge was decided upon. At this point a gorge some 250 ft. wide and about 350 ft. deep, with rocky sides almost perpendicular, crossed the line of the road at nearly right angles, so that tunnels opened on either side onto the gorge. It was impossible to get up the gorge from either end, so that all material had to be brought in through one tunnel or the other, and erected from each side on small shelves cut out of the solid rock. The Société de Construction des Batignolles (the well-known French bridge company) studied the location and designed and built at its shops in Paris the bridge described in the present article. This description is taken mostly from an article in "Le Génie Civil," Feb. 12, 1910.

The general outline of the bridge is shown in Fig. 1. It consists of a main arch formed by

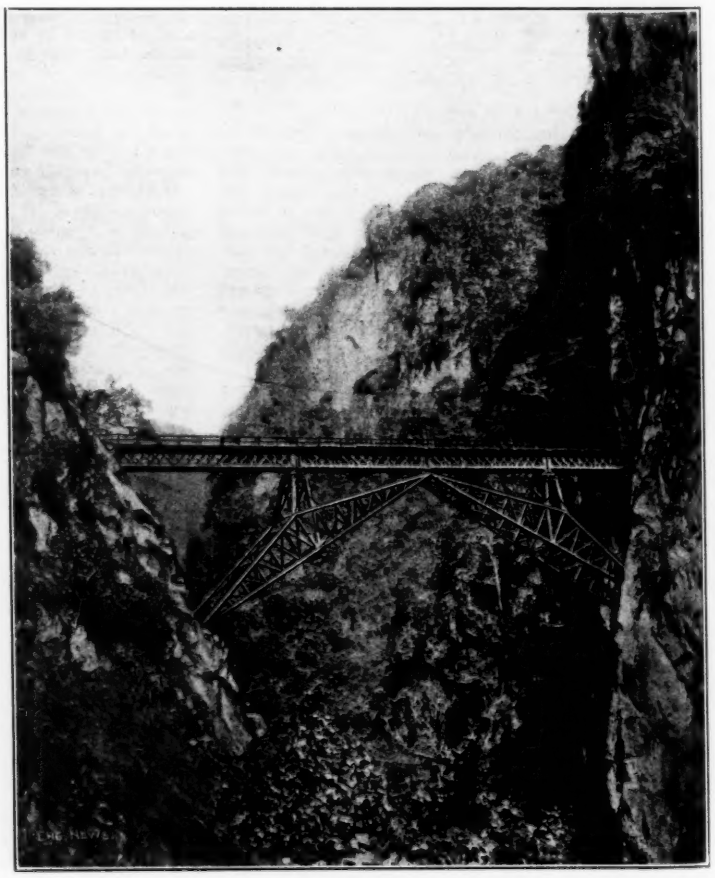


FIG. 2. VIEW OF THE NAM-TI ARCH.

*This bridge was noted in Engineering News, Oct. 7, 1909, p. 382.

two triangular trusses hinged at crown and spring and a roadway of discontinuous lattice trusses carried on high level abutments, piers resting on the haunches of the arch ribs and the crown of the arch. The principal dimensions are: total length of bridge, 220 ft.; arch opening, 180.6 ft.; height of rail above spring hinges, 60.6 ft., and height of rail above bottom of gorge, 335 ft. All the members that go to make up the arch ribs were made very light so as to permit of their transportation through the mountains either on man or mule back, and erected piece by piece, but the upper works of the bridge were made of heavier material brought in in larger bulk on the railway which by the time the arch ribs were erected, was completed up to the tunnel portal on the edge of the gorge.

MAIN TRUSSES.—Each semi-arch is composed of two triangular trusses placed in planes symmetrically inclined about 14% to a vertical plane. The truss is composed of a straight lower chord, made up of two vertical ⅜-in. web plates 13¾ ins. deep spaced 10 ins. apart with four 3¼ × 3¼-in. angles on the corners and an upper chord—in a broken line with variable section—consisting of two vertical ⅜-in. web plates, 13¾ ins. deep, 10 ins. apart, four 3¼ × 3¼ × ½-in. corner angles and with two top cover plates ½ and ⅝-in. thick at the points of maximum stress.

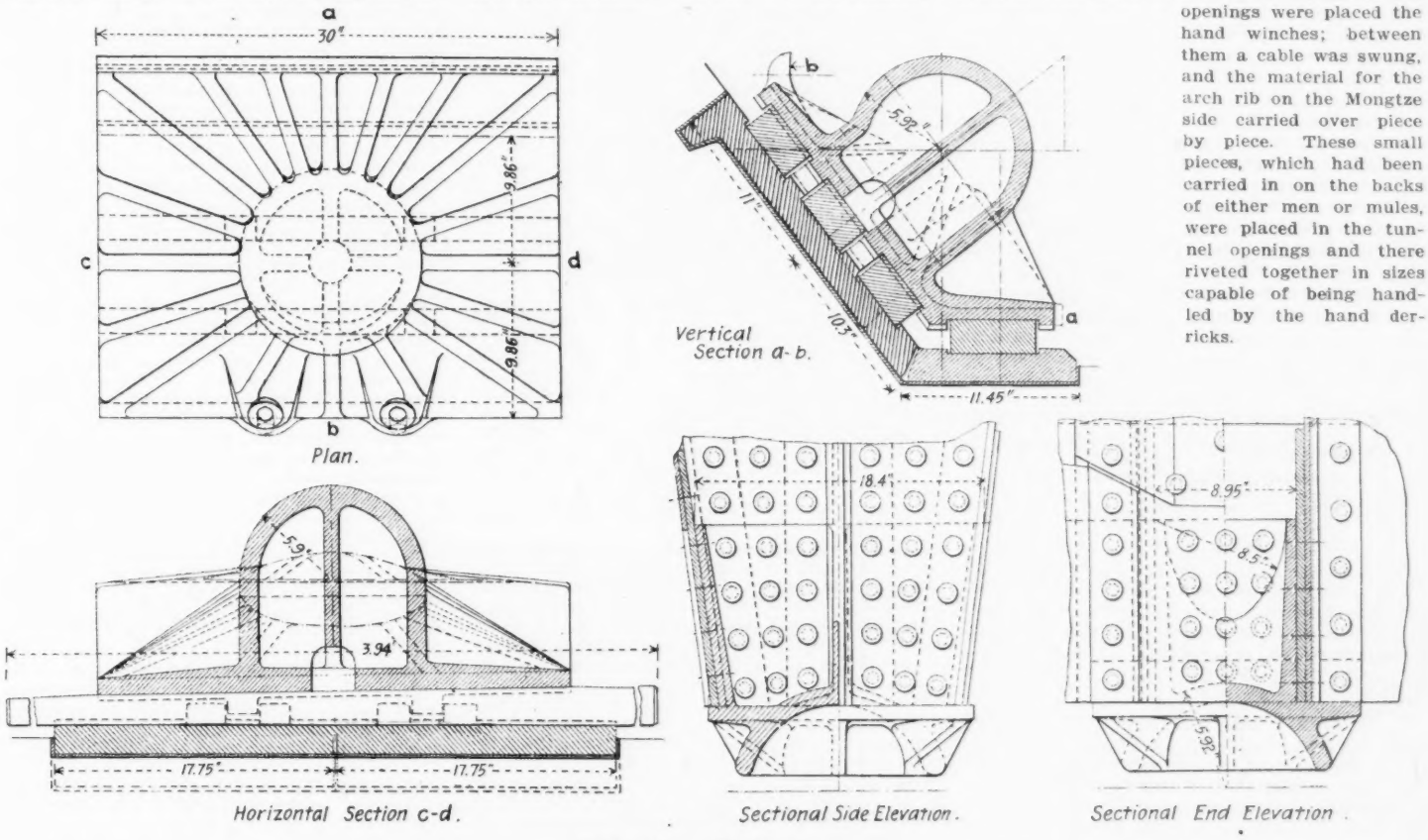
These chords are connected with posts and diagonals as shown, made up of two 2¾ × 2¾ × 5/16-in. angles connected by ties of suitable length. The stresses in these connecting members are quite small, except in those which are directly under the piers carrying the floor trusses. These are composed of four angles instead of two. Transverse bracing is supplied by X-bracing in the planes of the posts and diagonals and in the horizontal planes of the chords.

HINGES.—There are four spring hinges, one at each end of truss. Each consists of a lower cast-steel shoe bolted to the masonry of the abutment and provided with a spherical projection into which fits a spherical socket riveted to the base of the arch rib (Fig. 3). This spherical connection of the shoe rendered the setting of the base plate to meet the transverse inclination of the ribs a much more simple matter than would have been the case had the usual cylindrical pin hinge been used. The crown hinge is of the ordinary cylindrical type, a 7½-in. pin bearing against the open jaws of the upper ends of the trusses.

FLOOR SYSTEM.—The floor is of the ordinary single-track type of stringers and floor-beams resting on the upper chord of lattice girders. The girders are fixed at the crown of the arch but are on roller bearings at the abutments and at the intermediate supporting piers. These supporting piers are made up of four interbraced columns each inclined transversely at the same slope as the trusses and each made up of four 2¾ × 2¾ × 5/16-in. angles.

As shown on Fig. 4 the arch skewbacks and the truss abutments were made of cut stone masonry laid in openings cut from the solid rock.

METHOD OF ERECTION.—When the work on the bridge was started, only the small headings of the two tunnels on either side of the gorge had been completed, so that it was impossible to bring through them anything but the small pieces which went to make up the triangular arch ribs. These were brought through from the Lao-Kay side (see Fig. 4), together with a small hand winch and cable. Then immediately above the headings of the tunnels on either side excavation was made in the solid rock, and in the openings were placed the hand winches; between them a cable was swung, and the material for the arch rib on the Mongtze side carried over piece by piece. These small pieces, which had been carried in on the backs of either men or mules, were placed in the tunnel openings and there riveted together in sizes capable of being handled by the hand derricks.



Details of Shoe.

FIG. 3. DETAILS OF SPRING HINGE.

The footings for the arch shoes were first placed, together with the shoes, and upon these shoes on either side were erected the triangular trusses, swinging down the riveted pieces from the tunnel platforms by means of the derricks. These trusses were erected in a nearly vertical position, as shown on Fig. 4, in which position the posts and transverse bracing of the truss were in a horizontal plane, and upon these planes timber working platforms were placed as the work progressed. The various members of the truss were bolted together for this final work, and not riveted. These trusses were held in position during construction by cables and timbers, tied and braced, respectively, back to the walls of the gorge.

When each of the two arch ribs had been com-

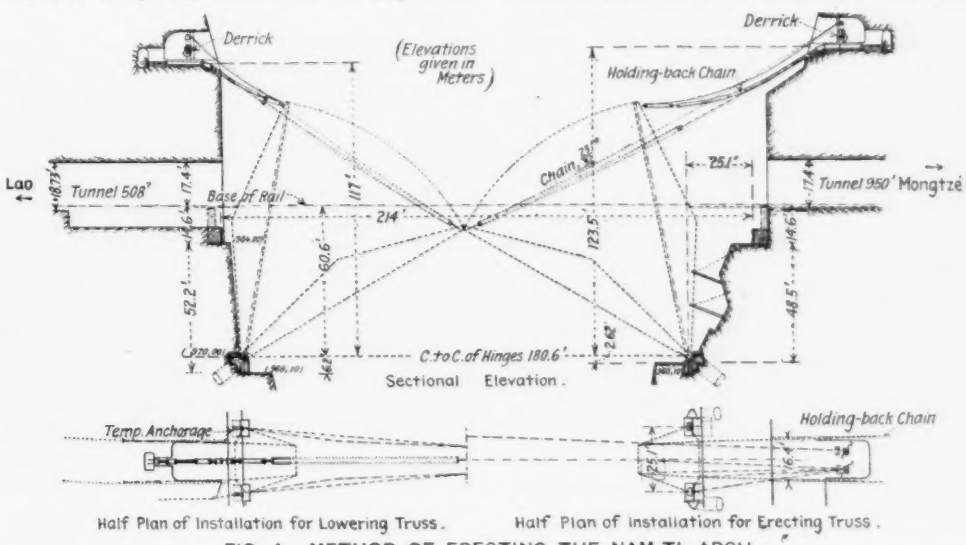


FIG. 4. METHOD OF ERECTING THE NAM-TI ARCH.

pleted from the lower to the upper hinge, heavy chain cables were attached from the upper end of each rib back to the derricks in the recesses cut in the rock, and the two arches were allowed to turn on their lower hinge until they came together at the upper hinge.

By this time the tunnels had been cut through to the gorge in full section, and the other material for the upper works of the bridge was brought through on the railroad. At the same time, heavier derricks were brought along and the work of erection proceeded under more favorable circumstances. The supporting piers over the haunches of the ribs were swung and riveted into place, and then the floor trusses were bolted together temporarily and erected by the end-launching method, being pushed over from the Lao-Kay side until the far end reached the Mongtze side. The four trusses were then lowered onto their respective bearings. The main arch ribs were then riveted at the joints where construction bolts had been placed and then the roadway was completed. The entire work took from March 11 to Nov. 30, 1908.

A Notable British Court Decision Regarding Stream Pollution by the Birmingham Sewage Works.

Thirty-five years ago the Parliament of Great Britain, inserted in its "Public Health Act, 1875," (Sec. 17, cited below), a drastic prohibition of stream pollution by the sewage of municipalities. That this prohibition has not always been enforced and that attempts at enforcement would give rise to much legal contention over the exact meaning of such sweeping language is obvious to anyone at all familiar with sewage disposal problems.

Ten years or so ago the Birmingham, Tame and Rea Drainage Board, which is responsible for the main sewerage and sewage disposal of Birmingham and vicinity, was forced to defend a suit brought by the Attorney-General in behalf of the Borough of Tamworth and the Tamworth Rural District Council to secure an injunction against the discharge into the River Tame of effluent from the sewage farms and from storm-water lagoons of the defendant district. The High Court of Chancery issued an injunction against the district, but did not at once issue the order necessary to carry it into effect. An appeal was taken, during the course of which the Supreme Court appointed its own expert (Sir William Ramsay), to conduct an investigation on its behalf. The findings of the expert, combined with a review of the law and of other facts in the case, led the appeal court to discharge the injunction.

The discharge of the injunction was based largely on the conclusion that, owing to improvements in the Birmingham sewage works, the effluent discharged into the Tame, although not equal in character to unpolluted water, is better than the waters of the stream and tends to improve those waters. The credit for the sewage works as now constituted, and presumably for the able handling of the lawsuit, is largely due to Mr. John D. Watson, M. Inst. C. E., Chief Engineer of the Birmingham, Tame and Rea Drainage District. Mr. Watson has kindly sent us an excerpt from the decision of the lower court, the full decision of the higher court, and some brief but interesting comments on Sec. 17, of the Public Health Act of 1875, and on the dissolution of the injunction.

We first give a portion of the Court of Chancery decision, by Judge Kekewich, as follows:

I find that, as a matter of fact, the Defendants convey into the River Tame by the discharge of lagoon water, and otherwise, water not freed from all excrementitious or other foul or noxious matter, such as would affect or deteriorate the purity and quality of the water in such river.

What then is my duty? The Defendants appeal to me not to grant an injunction. They allege, and the evidence fully supports that allegation, that they have been persistently struggling against great difficulties, and that they have met with a large measure of success, that there is no reason to believe that they will not persistently struggle, and that there is every reason to believe that success in the future will be greater than it has been in the past. Science in this particular department has made large strides in recent years, methods and processes which were formerly thought effective have been proved to be of little value, and there have been brought into prominence other methods and processes which have received the stamp of authority, and are regarded by scientific men as certain to hold the field. One of the discarded methods is purification by lagoons, but this method cannot, especially in such large works as those of the Defendants, be got rid of all at once, and time must be occupied in constructing the bacteria beds which are to take its place, and collecting the material necessary for that purpose. Within a reasonable time, say the Defendants,

We shall be able to satisfy the Plaintiff and the Court that we are no longer committing any offense against the Act, and we ask that we may have a reasonable opportunity for doing this without in the interval being placed under the ban of an injunction.

To this appeal I am not at liberty to accede. As I understand the law, the Attorney-General coming to complain that a public body is exceeding its powers or committing some offense against the statute, is entitled, as a matter of right, on proving his case, to the only relief which the Court can grant, namely, an injunction in one form or another. Convenience which sometimes assists the Court in other cases to avoid granting an injunction while making a declaration of right, is not, in my judgment, applicable to such a case as the present, where the Attorney-General is Plaintiff. Nor am I disposed to suspend the operation of an injunction. That method of procedure, ought, I think, to be limited to cases where it is desired to submit the question to a higher Court, or where certain works are proposed to be done to get rid of the cause of complaint, as, for instance, by abating a nuisance.

I do not think that the remedies which the Defendants propose to adopt are sufficiently certain or can be perfected within a sufficiently definite time to make that procedure applicable here. On the other hand, I think that the Defendants deserve gentle treatment. I will not repeat what I have said before about their endeavors in the past, or the certainty of their perseverance in the future, but all this deserves the benevolent attention of the Attorney-General, who, of course, looks at these matters from a public point of view, and must take into consideration all the difficulties which beset the Defendants in dealing with the vast problem entrusted to them, a problem, be it observed, involving practical question of the highest importance to the community at large, far beyond any discussed in this case.

Consideration of the whole position is a matter for the discretion of the Attorney-General, and it would be impertinent of me to say more. But I will venture to add this. An injunction cannot be enforced by any process without an Order of the Court, and the Court would be extremely reluctant to allow process to issue unless and until the Defendants have had a reasonable time for remedying the present state of affairs, and have neglected to use the opportunity thus afforded to the best advantage.

The Judgment in the "Supreme Court of Judicature, Court of Appeal," is dated Mar. 19, 1909. The main opinion and the order were handed down by the Master of the Rolls and were concurred in by Lord Justices Moulton and Farwell. Except for portions of the opinion dealing with the right of the Attorney-General to an order of injunction when he proves his case we give the Judgment in full, with italics as designated by Mr. Watson to bring out what he considers the most salient points in the Judgment:

Judgment.

THE MASTER OF THE ROLLS: *We will not trouble you, Sir Robert.* [Counsel for Defendant was not called upon to reply.] This is undoubtedly a case of great importance, not merely to the particular locality, *but, I think, to all public bodies and public Boards throughout the country.* The Birmingham District Drainage Board have statutory powers to deal with the sewage of Birmingham and a large tract of land, including several very important towns. They constructed sewage works, but those sewage works did not fully carry out the intentions of those who had constructed them, and it is plain—I do not wish to throw any doubt upon it—that whatever be the true meaning and effect of Sec. 17 of the Public Health Act, 1875, the Defendants in this case were guilty of a breach of that Sec. 17. The matter was tried before Mr. Justice Kekewich, the action having been commenced in 1899 and having stood over from time to time in order that the Defendants might see what could be done. It came on before Mr. Justice Kekewich in 1907, I think, and he decided—and I see no reason whatever to doubt the accuracy of his decision—that there was then a breach of Sec. 17, and he granted an Injunction in terms of Sec. 17, and made the Defendants pay the costs of the action.

Before I deal with the rest of the case there is one part of the Judgment of Mr. Justice Kekewich to which I am not prepared to give assent. He says on page 56 of 1908, 2 Chancery Division:

As I understand the law, the Attorney-General, coming to complain that a public body is exceeding its powers or committing some offense against the Statute, is entitled as a matter of right, on proving his case, to the only relief which the Court can grant, namely, an Injunction in one form or another.

I am not prepared to assent to that proposition.

* * *

Then it comes for us to consider what has happened since. The Defendants appealed against the Order of Mr. Justice Kekewich, and it was an appeal which undoubtedly was in form very peculiar. In substance it proceeded upon this footing: We are not really in a position to say that Mr. Justice Kekewich was wrong in granting the perpetual injunction he did, but we are satisfied by evidence that since the Judgment, at an enormous expenditure of money, we have so altered the situation that there is now no breach of Sec. 17. The evidence was most conflicting. The witnesses on one side said that so far from there being any pollution, the river was improved. The witnesses on the other side said:

That is really quite absurd: go and look just below the exit of your water, and anybody cannot fail to see sewage fungus.

We said, when this was before us in June, I think it was, this is a case in which the Court must have the assistance of an expert of the highest qualifications and of the highest position, who will go down there and who will see what is being done, attended at least once by representatives on each side, and who will give us the benefit of his assistance. We named Sir William Ramsay, of whose qualifications it would be impertinent of me to say a word, and he was requested

to inquire and report to the Court whether the sewage effluents from the Defendants' Works which enter the River Tame are before entering the said river entirely or to any or what extent freed from all excrementitious matter or other foul or noxious matters such as will affect or deteriorate the purity of the water in such river (1) at the points of entry or (2) within a distance of 600 yds. therefrom.

Now Sir William Ramsay has been good enough to furnish us with a most elaborate and careful report. I do not propose to go through it: suffice it to say that he has analyzed with the greatest care a large number of specimens of the water taken at the various points: the river before the effluent enters; where the effluent enters the river; and 600 yds. further down; and the conclusion at which he arrives in his Report I will repeat in his own words:

To sum up: My opinion is that the river is not made fouler by the entry of the Birmingham effluent. To adapt the terms of reference: The sewage effluents from the Defendants' Works which enter the River Tame are to such an extent freed from excrementitious matter and other foul or noxious matters that they do not affect or deteriorate the "purity" of the water in such river (1) at the points of entry, or (2) within a distance of 600 yards therefrom.

If the construction of Sec. 17 is that which the learned Judge, Mr. Justice Kekewich, thought it was, and which for the reasons I shall give in a minute I think it is, that, of course, is a clear and explicit finding that there is now at this moment nothing done by the Defendants in contravention of Sec. 17 of the Public Health Act. It is quite true that that Report is not a thing which is absolutely binding upon us: it is open to criticism by Counsel, as it has been criticised by Mr. Macmorran, but to imagine that we should not have regard to a Report by a man of that eminence in a case in which, apart from that Report, the evidence was absolutely contradictory, to suppose that, I think, is impossible. I therefore have no hesitation in saying whatever the result of the subsequent decision may be, I accept as the fact those findings which Sir William Ramsay has made in the two sentences which I have read. Well, but is that sufficient? Sec. 17 says this:

Nothing in this Act shall authorize any local authority to make or use any sewer drain or outfall for the purpose of conveying sewage or filthy water into any natural stream or watercourse or into any canal pond or lake until such sewage or filthy water is freed from all excrementitious or other foul or noxious matter such as would affect or deteriorate the purity and quality of the water in such stream or watercourse or in such canal pond or lake.

Now is that an absolute prohibition of conveying any filthy water into any natural stream, or is it only a prohibition against conveying filthy or sewage water in such a manner as prejudicially to affect or deteriorate? I will read what Mr. Justice Kekewich said upon that point. After reading the words of the Section, he says:

This, again, necessarily implies that excrementitious or other foul or noxious matter may be conveyed, for it is not said that none such shall be conveyed into any natural stream or watercourse, but only that there shall not be conveyed into it such as would affect or deteriorate the purity and quality of the water. It seems to me that on the grammatical and reasonable interpretation of the language what the legislature intended to prohibit was the deterioration, that is, the making worse the purity and quality of the stream or watercourse, and that no one can be said to have offended against the prohibition if as a matter of fact there has been no such deterioration.

It seems to me almost absurd to say that a man can

be guilty of a statutory offence under this Section if he has improved the water of the river by that which he casts into it.

I think, therefore, that the question which we submitted to Sir William Ramsay was the proper question to submit in a case like this, and that it is not true to say that there has been a statutory offense if the Defendants have put into the river some water which does contain a certain amount of filth, although it is so much better than the rest of the water which was in the river before that upon the whole it improves the character of the water; in other words, it cannot be said to deteriorate the purity of the water: on the contrary, it benefits it, and we must read the word "affect" in the sense of prejudicially affect or deteriorate the purity and quality of the water.

That being so, what ought we to do in this case? I cannot fail to regard this, that the Birmingham Board, the Defendants in this case, are a public body discharging a most important function, who have certainly not spared money, we were told upwards of £500,000 had been spent over the work, and they have done what they could—*not only have they done what they could, but actually, instead of damnifying, they have benefited the River Tame.* Under those circumstances is it right to say that this body should go on discharging their duties with a sword over their head in the shape of a perpetual injunction? I think not. *It may be that in the Order which we propose to make we are going further than has been done in any previous case which is reported,* but I think that the Order which I propose and suggest will, while removing this sword over the heads of the Defendants and while enabling them to discharge their duties without the prejudice created by such an injunction, at the same time impose upon them such obligations as the Statute desires should be imposed upon them, and will give to the Defendants all such rights as they ought to have. I think that the Order which we ought to make should be in this form, subject to any words which Counsel may suggest after Judgment has been delivered:

It appearing that the state of things existing at the date of Judgment has since been changed by means of the permanent works constructed by the Defendants so that there is no longer any breach of the statutory provisions contained in Sec. 17 of the Public Health Act, 1875, and the Defendants undertaking to use their best endeavors to prevent in future any breach of such provisions, no Order except that the Appellants pay the costs of the appeal.

MR. P. O. LAWRENCE: I beg your Lordship's pardon, it will not be "No Order," but to discharge the Injunction. That will be the substantive part of the Order.

THE MASTER OF THE ROLLS: Yes, you are quite right.

LORD JUSTICE FLETCHER MOULTON: I am of the same opinion, and I agree that this case raises a very important point, *a point very important for local authorities and for the public generally. The difficulty of dealing with sewage, now that our towns have grown so large, is very great, and seeing that sewage is now pretty well all water-borne, and that it must, therefore, go down natural channels to the sea, the terms and restrictions which have been put by the legislature upon the discharge of sewage into these natural streams become a question of great importance, and it is incumbent on the Courts to see that they do not make the remedies, which are in their hands for compelling these bodies to do their duty in this respect, TOO ONEROUS,* but that they interpret very carefully the legislative provisions as to purity, otherwise this task would be made quite impossible to perform. I think Sec. 17 of the Public Health Act evidences that the legislature has felt the great difficulty of the task, and it has taken a standard for performance which was, on the one hand, sufficient, to protect the public, but, on the other hand, was a practical one leaving the task of the local authorities a possible one.

Before I deal with the words of the Section I want to deal with the question of what is excrementitious or other foul or noxious matter. We all know that excrementitious matter, being of organic origin, is liable to change, and, as Sir William Ramsay has put it, if we are to take excrementitious matter to mean unchanged feces or urine, then the Defendants do not offend, because in their effluent there is none such. But to give it that meaning would, in my opinion, be to make the Section not sufficiently stringent to protect the public, because these organic bodies rapidly undergo change, chiefly in the way of oxidation, which makes them approach more and more definite chemical bodies of a stable character, such as are generally met with in what is called inorganic chemistry. Therefore what is present is more or less completely oxidized or burnt up excrementitious matter. *If we were to say, therefore, that the Statute meant that everything that had an excrementitious origin remained, no matter what changes supervened, still excrementitious matter, IT WOULD BE PERFECTLY IMPOSSIBLE TO PURIFY WATER THAT HAD ONCE BEEN USED AS SEWAGE, because the processes of purification do not remove the nitrogen and the oxygen and the carbon which existed in the excrementitious matter that was originally put into it: they only changed their combinations, and that which was put into the water must remain there, and would remain there all the time.*

Therefore you cannot say that because there is matter that is derived from excrement that therefore there is any excrementitious matter. That would be a ludicrous interpretation of it. The legislature, therefore, realizing that that which is put in the water remains in some form there except in some very minute portion which may become volatile with free ammonia, but even that would remain in the water in small traces, and seeing that it must remain there, they must have some practical definition of the duty of the local authorities in dealing with their sewage which cannot be based on the idea that you take out that which is put in. *It must be sufficient that that is so changed by subsequent chemical change that it becomes harmless from the point of view of the public and does no damage to them.* The test they have taken is an excellent one. They have said you may not discharge into a stream that which makes it worse. The consequence is if by carefully applying that to the upper waters of the stream the stream becomes more and more pure, then those that discharge in the lower waters of that stream must improve their methods, so that they do not interfere with that improvement. No body may make worse a stream by discharging the water into it that has received its excrementitious matter. The language of the Act seems to me not to possess any ambiguity. It says:

Nothing in this Act shall authorize any local authority to make or use any sewer drain or outfall for the purpose of conveying sewage or filthy water into any natural stream or watercourse, or into any canal pond or lake until such sewage or filthy water is freed from all excrementitious or other foul or noxious matter such as would affect or deteriorate the purity and quality of the water.

What you must not discharge in the stream is water that conveys that which will make it worse. That being the meaning of the Section, it seems to me that after this Report of Sir William Ramsay's, which, knowing well his eminence, I accept absolutely, we must come to the conclusion that the Defendants no longer offend against this Section. He says quite plainly that if excrementitious matter means actual excrement, whether feces or urine, then of course my reply is that it is absent. That is an interpretation we cannot adopt. Then he goes on to consider the presence of those more or less stable bodies which grade up from things almost as unstable as the original feces down to things just as stable as nitrates, and by well-known tests he examines the condition of the water just before you come to the sewage works and after the whole of the effluent has been put in. He finds in some things a most remarkable state of things with regard to the effluent. *It is fully oxidized, much better oxidized than the water of the river into which it is put, and he comes, as a conclusion, to this, that the effluent from the sewage works does not deteriorate the stream: IN FACT, IT RATHER IMPROVES IT.* The question of storm water has by admission gone. He points to the existence of green growth in the river, and gives abundant reasons for his coming to this conclusion, but it is the conclusion which is really important to us, and therefore I am satisfied that at last the admitted zeal of the Defendants and their desire to perform their statutory duties has led them, thanks to improvements in modern science, to a successful way of doing it, and that therefore the offense against this Section of the Act has ceased.

Now that being so, I think that it is not right for this Court to leave under the stigma of an injunction a public body that is conscious of its duties and doing its best to perform its duties, and one which has for years been striving to do them perfectly, as is found by the learned Judge in the Court below. *I think it is not right for us to do that when we are satisfied that that public body has at last succeeded, and is using means which will in the future be successful, because it took it a very long time to enable it to perform the gigantic task imposed upon it, and I thoroughly agree, WHETHER IT BE NOVEL OR NOT, that it is the duty of the Court in a case like the present, to make such an Order as that which the Master of the Rolls has just read out to you.*

LORD JUSTICE FARWELL: I am of the same opinion, and have very little to add. On the question of construction it appears to me that Mr. Macmorran's argument assumes the absolute purity and quality of all the streams, watercourses, canals, ponds or lakes, which is a proposition I cannot assent to. I should read the Section as meaning that it shall not affect such purity and quality as the stream may have, not absolute purity which the stream is to be assumed to have, which is really a proposition I can hardly attribute to the legislature.

The other point on which I desire to say something is the question which Mr. Justice Kekewich has disposed of, at page 562, where he came to the conclusion that he had no discretion and was bound to grant an injunction because the Attorney-General asked for it. In my opinion that is really a misconception. The injunction is only the form of remedy, or one of the forms of remedy, which the Court grants in aid of a legal right. The right is to intervene and to call the attention of the Court to a breach of the Statute. Of course, in a case of that nature there is no remedy in damages possible, but there is a remedy by declaration, and there is the remedy by suspending the injunction and by giving liberty to apply after the declaration without granting an injunction. The right to an injunction is certainly not absolute.

* * * * * * *

Now then comes the third point, as to our jurisdiction to intervene in the way which the Master of the Rolls has proposed, and with which I entirely agree. I think it is plain that this Court has authority, if it thinks fit, to say that the evidence being so and so, *the learned Judge should have made a mere declaration and should have let the question of the injunction stand over.* The learned Judge could certainly do that, and although it is a matter within his discretion, it is a judicial discretion which we might in a proper case review, although we should be unwilling to do so readily. *Further, he might have said, "This is not a case for doing anything more than this; I will grant the injunction, but suspend its operation"; and then, when he finds that the works have been absolutely completed so that the whole nuisance is removed, I see no reason why, having suspended the operation of the injunction for a time, he should not suspend it in toto.* Those matters come before us with the same jurisdiction which the learned Judge had, and I cannot doubt but that the learned Judge could have said, "I will not grant an injunction, but I will merely make a declaration." I cannot doubt that he had jurisdiction to say, "I will suspend the injunction for a time, or I will grant no injunction, but will accept an undertaking in lieu of an injunction," and the form of the undertaking may be different from that which is asked for. All those courses are equally open to us as to the Court below, and I see no reason why we should not, in a case like the present, where it is obviously beneficial to all parties, grant this alteration of the Judgment in the terms which have been already stated. It certainly does no harm to the Plaintiffs, because anything more cumbrous and unsatisfactory than a motion for a writ of sequestration in which the applicant is hampered by the fact that he has to prove wilful disobedience to the Order, it is difficult to conceive. He is much better off, to my mind, but at any rate I see no reason why we should not accede to the request of the Defendants, who say there is no case for an injunction, we have done our best, we never intended to be disobedient to any Order of the Court, *we have done a great service to the public as well as to the Plaintiffs, because we have experimented in a way which will be useful to all other public bodies.* I think myself that there is no difficulty as to our jurisdiction to make the Order, and I think it is right to do so.

[Here followed a discussion between Court and counsel regarding the costs. The conclusion was that the Defendant must pay the general costs, but some of the details as to costs of experts seem to have been left to the "Taxing Master."—Ed.]

We conclude with the following portion of Mr. Watson's letter of transmittal to us:

In my view the 17th Section of the Public Health Act, which is as follows:

Nothing in this Act shall authorize any local authority to make or use any sewer, drain, or outfall for the purpose of conveying sewage or filthy water into any natural stream or watercourse, or into any canal, pond, or lake until such sewage or filthy water is freed from all excrementitious or other foul or noxious matter such as would affect or deteriorate the purity and quality of such water or the water in such stream or watercourse, or in such canal, pond, or lake

is a section which it would be perfectly impossible for an authority placed on the upper reaches of a stream or river, and adjacent to their sewage works, to comply with. Notwithstanding all that my Board have been able to do towards the purification of sewage, we are well aware of the fact that it is impossible to bring back liquid, which has once been fouled, to a state of potable water, which presumably is the state of a river in its upper reaches, and although we have been able to obtain from the Court of Appeal a judgment to the effect that we are able to purify the sewage so as to avoid pollution, I feel that it will be necessary for communities generally to take steps to have Sec. 17 abrogated.

In this connection it is interesting to observe what Sir William Ramsay, K. C. B., F. R. S., reported to the Court, namely:

If "excrementitious matter" means actual excrement, whether feces or urine, then of course my reply is that it is absent. But if it means partly or wholly oxidized feces or urine the reply must be that there is some present. This definition would apply, though in a much less degree, to the water drunk by the greater part of the population of London which is drawn from the Thames and the Lea, and these rivers are polluted by large volumes of sewage effluent from the towns on their banks. It is needless to say that the sewage undergoes careful purification before it enters the rivers, and also that the water is further purified by storage in reservoirs and filtration through sand to such an extent that no danger is to be anticipated from drinking it.

I understand that this is the first time during the past 150 years that an injunction has been discharged after having been granted. In that respect it is—to use the words of Lord Justice Fletcher Moulton—"novel."

Gantry-Frame Two-Side Towing Locomotive for Lock Haulage, Bremen, Germany.

At a dam across the Weser River in Bremen, Germany, navigation is carried on through two locks, respectively 230 ft. and 1,150 ft. long. These locks were opened for use in 1908, and shortly afterward it became apparent that some means should be provided for hauling tow-barges through the locks, in order to reduce the lost time and increase the locking capacity. The center wall between the two locks, about 21 ft. wide, could be used as trackway for an electric towing locomotive, arranging the latter so as to be capable of hauling on either side. With previously used forms of canal tractor, two tracks would have been required, one along either edge of the wall. To eliminate this duplication, with its crossover switches and other complica tions, the novel gantry-frame tractor shown by the view herewith was designed by the Allgemeine Elektricitäts Gesellschaft (according to their "A E G Zeitung" of February, 1910).

The height and width of the frame were fixed by clearance requirements. The tractor had to pass over the gate-house, electric-light poles, etc., and pass under a future footbridge crossing the locks; also a space along the edge of the wall had to be left clear. The legs of the gantry thus were limited in width to about 28 ins. These dimensions made it necessary to place the driving motor in the overhead transverse girder.

A three-phase motor is used, operating at 220 volts; the three trolley-wires are suspended at a level just below the cross-girder. Reducing and bevel gears connect the motor shaft and the wheels; the two wheels on either side are coupled, all four wheels being driven. The locomotive was required to exert a tractive force of 3,300 lbs., which it accomplished readily. Beyond a certain excess of pull, however, the current is cut off by an overload circuit-breaker. Controllers are placed on both sides, so that the operator can work on the side nearest the load. There are separate controllers for the drums on which the tow-rope is wound, but whether these are driven by the main or an auxiliary motor is not stated. The tow-ropes can be paid out to a length of 300 to 350 ft. each.

Current is taken from the city lighting mains at 7,000 volts three-phase, transformed to 220 volts in a transformer house on the land side, and taken through the lock by a subaqueous cable. The trolley current is also used for lighting, two 50-c. p. metal-filament lamps being mounted on each trolley-line pole. The whole equipment was completed and put in service in September, 1909.

The Elimination of Railway Grade Crossings.

A report on the elimination of grade crossings within the limits of Greater New York has just been submitted to the Public Service Commission of the First District of New York State by Commissioner Edward M. Bassett. The report gives not only the situation with regard to grade crossings and their elimination in New York City, but a summary of what has been and is being done in the work of grade-crossing elimination in several states and cities.

There are at present in Greater New York about 457 places where steam railways cross streets at grade. During the 2¼ years from July 1, 1907, to Jan. 1, 1910, 56 persons were killed and 100 injured at these grade crossings. Even these large figures do not show all the grade crossings and grade-crossing accidents in the metropolitan district, because the large area located on the New Jersey side of the Hudson River, with its million and a quarter population, is not included.

The state of New York has had since 1898 a law providing for the elimination of railway grade crossings. Under this law the cost of eliminating a grade crossing is paid, one-half by the railroad, one-quarter by the municipality or town in which the crossing is located, and one-quarter by the state. During the eleven years since the law has been in operation, the state has expended $1,617,000, the cities an equal amount, and the railways $3,235,000.

The greatest defect in the New York law appears to be that the work of grade-crossing elimination is delayed because of the lethargy of the state in appropriating money to meet its share of the work. Railways and cities are generally anxious to proceed with grade-crossing abolition on a large scale. The railways, in many cases, find that the elimination of the crossing saves enough money to the company, through doing away with the necessity for flagmen and slackening speed, to pay good interest on the cost of the work. In the New York Legislature of last year, a bill was offered, prepared by the New York City government, making special provisions for grade-crossing elimination in New York City. One clause of this bill, providing that the portion of the expense borne by the city should be assessed upon real estate specially benefited by the improvement, raised such a storm of protest that the bill was defeated.

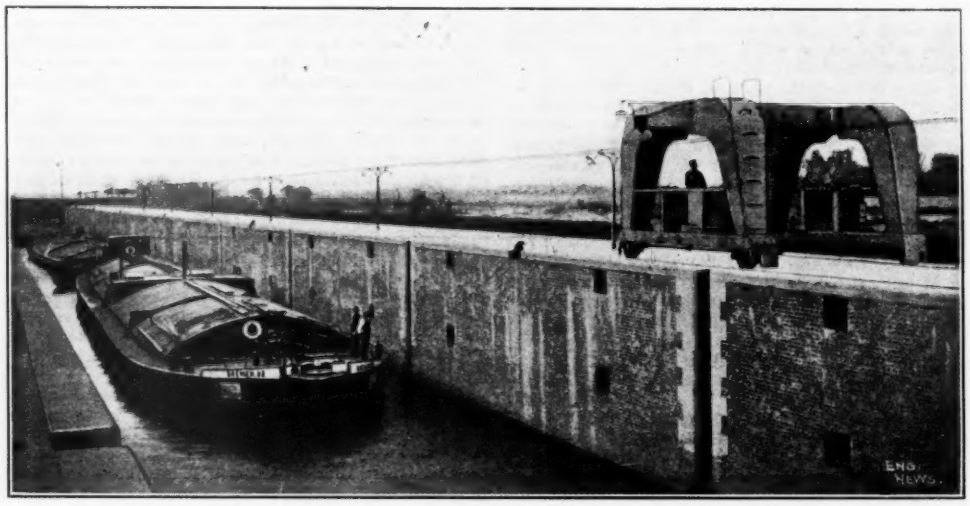
Commissioner Bassett recommends that an entirely new grade-crossing law be enacted by the legislature covering the whole state instead of New York City alone. He believes it no longer necessary to rely upon the state treasury to pay part of the cost of grade-crossing removal, and urges that railways and cities be permitted to bargain with each other as to the division of expense between the two in the elimination of grade crossings. In case the two are unable to agree, he proposes that the Public Service Commission be given authority to adjust the division of expense, subject to confirmation by a court in case of appeal.

A very important feature of the proposed law is that a plan for a general lay-out of streets and railway lines over a considerable district can be prescribed by the Commission after investigation of the entire situation. The need for some power of this sort is illustrated by the present situation in the Borough of Queens. Before the Greater New York was created, the Borough of Queens contained a number of independent towns and cities, not one of which had adopted an intelligent plan of street lay-out and management. The different centers of population each had their straggling streets leading nowhere in particular, and including many streets laid out by real-estate schemers. Here and there were sections where the original owners of the property had endeavored to preserve for themselves the title to the streets while selling the lots adjacent. The whole area was crossed by a network of railway lines, the grades of which had been fixed without the slightest regard to the avoidance of grade crossings. Since the Greater New York was formed, much work has been done toward preparing an intelligent street lay-out for this borough, in accordance with the plan provided for in the charter; but the railway grades have been a great obstacle to completing this. The borough is being rapidly built up, but little progress is being made in determining street grades. The inevitable result will be enormous expense at some future day for property damages on account of changes of grade to remove grade crossings.

Turning now to the second portion of Commissioner Bassett's report, we note briefly his summary of the work of grade-crossing removal elsewhere. The state of Massachusetts led the way, with its grade-crossing law of 1890. In the 19 years since, 192 grade crossings have been eliminated in Massachusetts, at a total expense of $30,632,000. Of this amount, $18,690,000 has been paid by the railway companies, nearly $8,000,000 by the state, and a little over $4,000,000 by the cities and towns. In Chicago, the entire work of grade-crossing removal has been paid for by the railways under a compulsory ordinance passed by the City Council. One hundred and thirteen miles of railway have been elevated and 35 miles more are to have their crossings eliminated by ordinances which have been enacted, but under which work has not yet begun. At least eight subway crossings carrying streets under the tracks are required for each mile of track elevation. The grade of subway crossings is usually fixed at 3½%, and the maximum clearance now required is 13½ ft. Five hundred and fifty-nine subways are under construction or completed, and 161 more are provided for by present ordinances. The railways have spent $53,662,000 on the work in Chicago, to date, and it is estimated that the ultimate cost of track elevation within the city limits will approximate $150,000,000. The work already completed has reduced grade-crossing accidents in Chicago from 282 in 1899 to 47 in 1908.

In the state of Connecticut, from 1889 to 1908 there were 232 grade crossings eliminated, out of a total in the state of 1,193. Each railroad company is required to remove at its own expense one grade crossing annually for every 60 miles of railway owned or operated. There is also provision for participation of the state and of the towns in the expense of abolition, when the work is undertaken on their initiative.

In Buffalo, N. Y., under a special act, 65 grade crossings were removed between 1888 and 1908. The general plan in Buffalo has been to make little or no change in the railway grades, but to carry streets either over the railway by viaduct or underneath by a subway, according to the topography.



"ELECTRIC MULE" AT LOCKS OF WESER RIVER DAM, BREMEN, GERMANY.

PASSENGER SUBWAYS under busy street intersections, to enable pedestrians to cross the street safely are being constructed in London at the so-called "Elephant Circus," or "Elephant and Castle." As described in the "Contract Journal" of March 30, these street subways consist of tube tunnels 8 ft. inside diameter. Stairways lead down to these tubes, and an underground room 20 × 23 ft. at the junction of the tubes enables passengers to cross in different directions without crowding. It is stated that at the street intersection where this subway is to be made the average number of pedestrians per hour in April, 1907, was 18,654, and the number of vehicles passing was 2,155 per hour.

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Two features of the important court decision on stream pollution, printed elsewhere in this issue, deserve special mention. The first is that the Supreme Court of England has set aside an injunction against the Birmingham (district) sewage works on the ground that although the effluent from the works has not, in the past, been free from evidences of sewage matters, and is thus a violation of the Public Health Act of 1875, yet the effluent is better than the stream that receives it, and there is prospect that it will become still better as improvements of the works are continued. The other notable feature of the judgment is its citation of the fact that the court employed its own expert to gather and submit independent evidence on actual conditions above and below the sewage-works outlet, *and placed implicit confidence* on the *findings of fact and opinion* submitted by its expert. This court expert was a no less distinguished person than Sir William Ramsay, Professor of Chemistry at University College, London, and discoverer of argon and helium.

The section of the British Public Health Act of 1875 on which this suit was based is very sweeping in character. If strictly interpreted and rigidly enforced it is questionable whether every sewage works in Great Britain would not have to be shut down and all water-carriage systems for the disposal of household wastes abandoned. The section has doubtless served a useful purpose, but like many another attempt to regulate highly technical matters by legislation and the courts instead of by a technical administrative board this one has fallen far short of its object and caused no end of needless trouble to many of the sewage authorities of England. It is a pleasure to record that the British Supreme Court has interpreted the Act in accordance with a rational view of local conditions.

The employment of an independent technical expert by the British court, the apparent freedom of the expert from the harassments of the lawyers, and the unquestioned acceptance of the findings of the expert all form a strong contrast to American court practice upon which we need not dilate.

A valuable classification of the typhoid statistics of the larger cities of the United States, presented by a contributor elsewhere in this issue, shows that, while a few cities now have rates of 15 to 10 or less per 100,000, there are many whose rates are 20 to 30, and on upward to 100 or more. The article in question discusses the causes of these variations and the means which may be taken to bring the cities with excessive rates down to reasonable limits. The text and tabular matter alike deserve careful study. Particular attention may profitably be given to the high rates which prevail generally throughout the southern part of the United States, and also to the large number of states whose vital statistics are still so unsatisfactory as to keep them out of the registration states.

The United States is rapidly losing its place as the great source of food supply for Europe. Notwithstanding the very high prices which all classes of food now command, the total value of foodstuffs exported from the United States in the fiscal year 1910 will be only about 330 million dollars, while in 1898, a year of phenomenally low prices, over 550 million dollars' worth of food was sent abroad. A comparison by quantity of leading food staples exported is given in the following table:

Product.	Approximate quantity to be exported in fiscal year 1910.	Quantity exported in other years.
Live cattle..	175,000 head	593,000 in 1904
Fresh beef..	75,000,000 lbs.	350,000,000 lbs. in 1901
Bacon	180,000,000 lbs.	650,000,000 lbs. in 1898
Wheat	50,000,000 bu.	157,000,000 bu. in 1892
Corn	36,000,000 bu.	209,000,000 bu. in 1900

The bearing of these figures on matters of traffic and transportation is obvious. Export trade is cutting a smaller and smaller figure in the traffic movement to the seaboard while domestic trade looms larger and larger. Again, these figures reveal an enormous increase in domestic consumption. The population of the United States has grown rapidly during the past decade while the production of the farms per acre of tilled land has decreased. Only the settlement of new lands and the reclamation of arid and swamp lands has kept production from falling off.

The Pittsburg graft revelations ought to cause a thorough-going reform of financial as well as political institutions in the Smoky City. In Pittsburg there was a variation from the old story of buying up aldermen to help through a city contract. The votes of the city councilmen were bought to secure the deposit of the city's moneys in certain banking institutions. Now why did these bankers undertake the commission of a felony? Why did they deliberately plan and carry out the bribing by wholesale of the city council members in order to secure the city deposits for their banks? Is it reasonable to suppose these bankers entered on this dangerous and criminal job out of pure zeal to benefit the bank's stockholders, by increasing its earnings?

Human nature is not made that way. When a crime is uncovered a motive for the crime must be sought.

Those who paid many thousands of dollars to secure the deposit of city money must have been exceedingly anxious to obtain it. They must have had use for that money other than its use in safe and legitimate banking. They would not have risked personal arrest and punishment unless they had personal ends in sight.

And if these Pittsburg bankers were willing to commit crime in order to get the city's funds where they could use them for their own personal schemes, what about the money belonging to depositors? Was that perhaps already in use to further some personal speculative scheme instead of being employed in safe and legitimate banking channels?

It is worth emphasizing that the whole financial and commercial life of a business community depends upon the character of its banking institutions and that means the character of the men who conduct them. The banker always and inevitably occupies a position of trust. The funds in his custody are trust funds.

If the integrity of the men in control of the banking institutions of a city is impaired, it affects the credit of every business firm. A foundation is at once laid for runs upon banks and commercial disaster. It was exactly that situation that precipitated the panic of October, 1907, in New York City. Apparently Pittsburg needs a thorough house-cleaning, in other places as well as in the City Hall.

The Bill to Increase the Engineer Corps.

Two weeks ago, in our issue of April 7, we discussed the bill reported by the Military Committee of the House of Representatives on March 23 to increase the Engineer Corps, and declared that the bill was a disappointment so far as bettering the position of the United States Assistant Engineers is concerned.

In our department of "Letters to the Editor" this week, a defense of the bill is presented by Gen. Mackenzie, late Chief of Engineers, and a statement is also printed from the committee of the American Society of Civil Engineers which attempted to have the bill so framed as to do justice to the civilian engineers. Our readers thus have both sides of the question presented, and, with the text of the bill which is printed therewith, they can form their own judgment on the matter.

Briefly summed up, Gen. Mackenzie considers that we are in error in thinking that the bill as it now stands does little for the civilian engineers. To show that we were not alone, however, in our impressions of the bill, we venture to submit extracts from two or three personal letters which we have received. One engineer writes:

> Allow me to extend my hearty congratulations upon your editorial on the bill to increase the Corps of Engineers, in Engineering News of April 7. A copy of the bill and the report thereon reached me the day before your paper, and I found all my thoughts and sentiments voiced in your editorial.

Another engineer writes:

> Permit me to congratulate you on the best editorial you have ever written from the standpoint of the civilian assistants under the United States Engineer Corps.

Still another says:

> I have read with great satisfaction your editorial in Engineering News of April 7. I have no doubt you might have made it much stronger if you chose, as I fully understand the situation. I believe this matter is important to the whole engineering profession, and it has been surprising to me that the bill has not been taken up more strenuously by all the engineering papers, engineering societies and engineering schools. Certainly you have done your part.

If, then, we were mistaken in our view of the bill, it appears that other engineers were similarly in error. But were we mistaken? How much does this bill amount to, really, with respect to the interests of civilian engineers? It opens, we grant, a very, very small door by which a very, very few civilian engineers may receive commissions as Second Lieutenants, in lieu of West Point graduates. Possibly the bill as it now stands may open the door a little wider than it was in the bill as originally drafted. As to that, the wording of the bill is so obscure, and so many factors are involved, that it is extremely difficult to form a positive conclusion.

The bill provides for a total of 43 Second Lieutenants; it provides that the vacancies created by it shall not cause the promotion of more than two Second Lieutenants per annum; it provides that, "so far as the interest of the military service will permit," any number of West Point graduates may be commissioned as Second Lieutenants. Last year 15 out of 101 West Point graduates of the class of 1909 were commissioned in the Engineer Corps. It is true that the Chief of Staff, Gen. Bell, urged in the hearing on the bill that the need of other branches of the service be borne in mind and that an undue proportion of the graduating class should not be assigned to the Corps of Engineers. But it should not be forgotten that a bill is pending to increase the number of students at West Point. It looks very much, therefore, as if the small crack which may possibly be opened to let an occasional graduate of some other engineering school receive a Second Lieutenant's commission, would be permanently closed after a few years.

It is not without interest in this connection to notice that the Corps of Engineers is the only branch of the service whose officers are all West Point graduates. Only 43% of all the commissioned officers of the army to-day are West Point graduates, and during the last ten years, according to the statement of Gen. Bell in the hearing on this bill, West Point has provided less than one-third of the total number of officers commissioned in the army.

Much more might be said on this point; but in our opinion the feature of this bill of most interest to the engineering profession was the prospect of bettering the position of the United States Assistant Engineers of long experience and large ability who have devoted the best years of their life to this work. More than this, in the public interest it is a question whether the chief responsibility for important works of river and harbor improvement is to be laid on inexperienced young West Point graduates, or on civilian engineers of long experience and high standing. As the bill now stands, all it says regarding these Assistant Engineers in any way, shape or manner is a clause in Section 4 which gives authority to the Chief of Engineers to place such Assistant Engineers in charge of river and harbor districts, or make them members of engineer boards.

Now, what and how much does this mean? The committee of the American Society of Civil Engineers thought that it meant very little. Hence they drafted an amendment which would have required these positions of responsibility to be filled by men with at least five years' experience, whether they were civilians or engineer officers. The Chief of Engineers, it appears from the memorandum printed in this issue, objected to this restriction and indicated that the whole matter should be left to his judgment.

It therefore becomes a matter of interest to inquire just what construction would be placed upon this Section. We have before us the report of the hearing held on this bill by the House Committee on Military Affairs. The statement made by Gen. Mackenzie at this hearing is explicit and, we may assume, authoritative. We therefore print it as follows:

MR. PRINCE. Now, if you had Section 4 as a provision giving you authority to employ these men, how many could you employ in that way?

GEN. MACKENZIE. I should say very few, Mr. Prince. As I understand that section, I would be perfectly free to say that that section is not, as I understand it, with any thought of changing the present superintendence of work. It was simply a case of emergency and for the time being that the Chief of Engineers might be authorized to do this.

MR. PRINCE. Then it is more suggestive than a working plan to put in operation now?

GEN. MACKENZIE. It would be a working plan, with the plain statement that I make. It is the intention to put an Assistant Engineer in charge of districts if the proper conditions should arise. I have some in mind now, and I think General Marshall has. It is only a few cases.

This strikes us as a frank, straightforward statement. The situation simply is that the Corps of Engineers has not at present enough commissioned officers of long experience to fill all the responsible posts. The Chief of Engineers wants authority, therefore, to meet this present emergency by placing a few, and "only a few," of the civilian Assistant Engineers in places of temporary responsibility. Gen. Mackenzie's statement is that this arrangement is a temporary one only, "for the time being," to bridge over the existing situation until, a few years hence, the younger officers of the Corps can attain enough experience to supersede the few civilians who may have temporarily been placed in charge.

In thus criticizing the pending bill, we would not be understood as criticizing the Corps of Engineers. As our readers know, we have been foremost in testifying to the splendid work of the members of that organization; and we do not believe the bill as it stands represents the best thought of the best men among the engineer officers. In fact, we know, from letters received by us, that a fair recognition of the men of ability and long experience among these United States Assistant Engineers would meet the cordial approval of many of the officers under whom they serve. And it is furthest from our intention to revive the old controversy between military and civilian engineers. Rather would we appeal for a fair and broad-minded adjustment that shall do justice to both parties. The present occasion forms an opportunity for such an adjustment that may not be repeated. It is greatly to be hoped that the bill in question may be withdrawn and amended to bring about that desirable end.

A Remarkable Record in Low Cost Freight Haulage on a Railway of Heavy Traffic.

Fifteen years ago there was active agitation in the Pittsburg district for the construction of a ship canal to connect the Ohio River with Lake Erie. The promoters of the project claimed that with the enormous volume of coal and ore traffic between the ports on Lake Erie and the furnaces and mills in the Pittsburg district, a ship canal would be a profitable enterprise and would effect large reductions in the cost of transporting raw material to the Pittsburg furnaces. At that time Mr. Andrew Carnegie was still active in the affairs of the Carnegie Steel Co., and he and his advisers gave careful attention to the project. Their final conclusion was that it would be more to the advantage of the Carnegie interests to build a low grade railway line of their own from Pittsburg to Lake Erie than to assist in the construction of a canal. Mr. Carnegie stated years ago that the investigations then made convinced him that the railway was a cheaper means of freight transportation than any canal.

Following this conclusion, the Carnegie interests constructed the Bessemer & Lake Erie R. R. It was built and has been operated with special regard to the economical handling of heavy freight traffic. Hence its operating records have always been of special interest.

This railway has now been in operation twelve years. It began in 1897 with a total freight traffic of 1,151,000 tons. In 1909 it carried 12,590,000 tons, exceeding by over a million tons the traffic of the banner year 1907. While it was built primarily to bring ore from the Lake ports to the Carnegie furnaces, it handled last year over 5,000,000 tons of freight other than ore.

The railway is notable among all the railway lines of the United States, or for that matter of the world, by its very large average freight-train load. In the year 1909, the average tons of revenue freight carried per freight train was 993. Even this large figure, however, does not fairly represent the success which the road has attained in moving trainloads, for the north-bound traffic is only a third of the south-bound traffic; consequently, while the number of trains run north and south is about the same, a large proportion of the cars in the north-bound trains are empties. To see the results actually attained in moving full train loads therefore we must take south-bound traffic alone. The average south-bound train on the Bessemer & Lake Erie last year carried a paying load of 1,484.48 tons, a record not only not matched, but not even approached, so far as we know, by any railway anywhere.

As the bulk of freight moved by this road is handled for the steel companies which own and control it, the freight rate is placed at a low figure. The average receipts per ton-mile in 1909 were only 4.45 mills, and this rate includes terminal expenses on a railway only 144 miles in length. Notwithstanding this very low freight rate, the great volume of the traffic and its movement in heavy trains made the operating expenses so low that the percentage of operating expenses to operating revenue was only 53.62%—another figure which it would be difficult to match on any railway anywhere. On this basis the cost to the railway of hauling a ton of freight a mile is given in the report as only 2.30 mills.

This cost, however, includes the terminal expenses as well as the road expenses. These terminal costs are a large item in the total operating expenses. The mileage run by switching locomotives last year was one-fourth as great as the mileage run by freight locomotives. The total length of the road is only 144 miles, but there are 157 miles of sidings, yards and traffic spurs. From these figures it is evident that terminal expenses must form a very considerable part of the total cost of operation, and the figure quoted above, of 2.30 mills per ton-mile as the cost of hauling freight, must be very materially reduced to obtain the actual cost per mile of hauling on the open road.

It may be said that this figure of 2.30 mills per ton-mile is the cost of operation only and does not include the interest on the investment in the railway and its equipment. The volume of freight traffic is so huge, however, that these interest charges do not increase the cost very materially. The report before us does not give financial figures; but if an allowance of $800,000 per annum be made to cover interest on the investment, it would increase the cost per ton-mile only about half a mill.

It is of interest to examine the figures given in the report for the average charges and expense per ton of freight handled.

Fifteen years ago, when a Board of Engineers reported on the Lake Erie & Ohio River Canal project, the freight rate on ore from Ashtabula to Pittsburg was $1.15. Last year the average receipts of the Bessemer & Lake Erie R. R. per ton of freight, including in this high-class merchandise freight as well as ore and coal, was 53.36 cts. The average cost of handling this freight was 27.57 cts. It must be remembered here again that these figures include the terminal expenses at both ends of the line as well as the cost of hauling over the road.

We have referred above to the handling of freight in heavy trains as one important element in reducing the operating expenses. An element almost equally important is the use of large capacity steel cars and loading these cars to their full limit. The cost of handling a ton of freight in the switching yards is very much lower with 50-ton cars than with 30-ton cars. Out of a total of 9,915 freight-equipment cars on the Bessemer & Lake Erie R. R., 8,400 are steel cars. The cost of repairs for these cars last year was $47.51 against an average cost for repairing wooden cars of $64.66. Further, this cost of repairs to the steel cars is really in excess of the actual wear and tear, as it includes the cost of replacing cast-iron wheels with steel wheels on many of the cars. If the outlay for steel wheels were deducted, the cost of steel car repairs last year would have averaged only $32 per car.

Another figure in the report, of much interest, is the earnings and expenses per train-mile. The average freight train earned last year $4.42 per mile run, and the cost of running it was $2.29. Notwithstanding the enormously heavy trains hauled, the locomotives made an average of 30,785 miles in the year, and the cost per locomotive-mile was only 29.4 cts. Coal for locomotives cost only $1.28 per ton, which, of course, helped to keep the total cost low.

Another thing for which the Bessemer & Lake Erie R. R. is notable is its extensive use of Carnegie steel ties. The first section of half a mile was laid with steel ties five years ago, and the company has purchased, up to Dec. 31, 1909, 366,355 steel ties. A total of 116½ miles of track is now laid with steel ties, and 18.7 miles additional will be laid with ties which have been ordered. General Manager Utley states in his report that among the advantages found from steel ties is that a section of track laid with them, when once put in proper line and surface, does not require as much attention to maintain it as is necessary on tracks laid with wooden ties.

The Use of Steam Turbines for Ship Propulsion.

At the meeting of the Institution of Naval Architects in London last month, the subject which attracted by far the greatest interest was the application of the steam turbine to the propulsion of vessels. We printed last week a summary of the paper by Hon. C. A. Parsons describing the equipment which his company has applied

to a tramp steamship. As was there recorded, the reciprocating engine was removed, and in its place was installed a steam turbine, driving a pinion with helical teeth meshing with a gear-wheel on the screw-propeller shaft. The speed reduction was about 20 to 1.

The turbines used were compound turbines on the Parsons system, the high-pressure turbine being 3 ft. maximum diameter by 13 ft. length, and the low-pressure turbine 3 ft. 10 ins. in diameter by 12 ft. 6 ins. in length. A flexible coupling was used between the pinion shaft and the turbine. Mr. Parsons claims that with this construction the pinion teeth take an even bearing upon the gear teeth, so that the "floating-frame" mounting used by Mr. Westinghouse in his type of speed-reducing gearing (Eng. News, Dec. 30, 1909) is not necessary.

The steam turbine and reducing gear installed by Mr. Parsons' company weighed about 25% less than the reciprocating engine which it displaced, showed an increased power of about 20%, and about 20% reduction in coal consumption. The efficiency of the speed-reducing gear is probably as high as 98%. This high efficiency alone, to say nothing of the matter of simplicity, would seem to make it well-nigh certain that the mechanical gear, rather than the electric or hydraulic system of speed reduction, will be the coming method of driving propellers from steam turbines, provided, of course, that the former system can establish its claims to absolute reliability and freedom from breakage.

With the electric system, which was also described at the Naval Architects' meeting, the steam turbine drives an electric generator at high speed, and the current from this generator is used to drive a low-speed motor mounted directly upon the propeller shaft. With the best attainable electrical efficiency, the loss of power in this double transformation can hardly be less than 10%, and is much more likely to reach 15 to 18% when all the sources of loss are included. This means not only a heavy direct loss in power and an increase in coal consumption, but it means, in large-power vessels, the delivery of a great quantity of heat in the engine-room, which is an exceedingly objectionable matter on shipboard.

The hydraulic systems stand on an even worse basis than the electrical, as regards efficiency. In principle, the hydraulic system consists of a centrifugal pump mounted on the steam-turbine shaft delivering water to a hydraulic turbine mounted on the propeller shaft. The waste water from the turbine is piped back to the centrifugal pump, so that the water flows in a closed circuit. Allowing even the highest recorded efficiencies for pump and turbine, the final loss of power is pretty certain to be not less than 20% of that generated by the steam turbine. Practically all this loss of power goes to heat the water flowing in the closed circuit. In an installation of any size, the amount of heat is so great that the cooling of the water to enable its continued use forms an almost or quite insuperable problem.

Besides these reasons, the great cost and complexity of an electric or hydraulic system, compared with the simple mechanical connection of two parallel shafts of different speeds by ordinary toothed gearing would seem to make the superiority of the latter system, from the commercial point of view, absolutely unquestionable.

It was noticeable that in the presentation of the paper, and in the general discussion before the society, quite a different view was taken of the marine steam-turbine from that taken by Mr. Westinghouse in the articles which we have published. Mr. Parsons claimed that for high-speed vessels the present equipment of steam turbines mounted directly upon the propeller-shafts is satisfactory and made the rather surprising claim that the efficiency of the turbine propellers used on the fastest ocean steamships was within about 5% of the maximum obtainable. Other speakers, however, criticised this figure and set the loss in the high-speed propellers with fine pitch used on turbine-driven vessels at a very much higher figure. It is noticeable, also, that Mr. Parsons in his discussion was, naturally, assuming the use of the Parsons type of turbine for driving the vessels. With this type, a comparatively moderate rotative speed is attained at considerable sacrifice of weight, bulk and complexity. By the use of turbines of much higher speed, it is possible to build a machine very much more compact and economical. From this point of view, therefore, there would seem to be good reason for belief that the plan of gearing the turbine to the propeller may come into use for war vessels and high-speed passenger vessels, as well as for the slow freight vessels which form the bulk of the merchant marine.

An interesting historical point brought out in the discussion before the Naval Architects was that the use of gearing between the engine and the propeller is a reversion to a system that was tried by many inventors in the early days of steam navigation. When it was first attempted to drive screw propellers by steam-engines, the difficulty met was that the steam-engine of that day was altogether too slow to drive the propeller shaft direct. Various types of gears were designed, therefore. John Stevens, of Hoboken, to whom the honor of original invention of the screw propeller is generally awarded, ran a steamboat in 1812 in which the engine was geared to twin screws. At that time, however, the problem was one of increasing the rotative speed obtained from the engine. Now the problem is reversed, and the thing to be done is to reduce the rotative speed to which the steam turbine is adapted. The gearing used by the millwrights and shipwrights during the first half of the 19th century was of the crudest construction and workmanship, and the resulting inefficiency and noise was a great element in causing it to be early discarded. The reintroduction of gearing at the present day is made possible through the development of machinery and metallurgy by which gears are cut with an accuracy that was undreamed of half a century ago, and of materials with a strength and resilience that was likewise far beyond the conception of the early engineers.

LETTERS TO THE EDITOR.

The Bill for Increasing the Corps of Engineers.

Sir: An editorial appearing in your issue of April 7, 1910, has given me the impression that certain provisions in House of Representatives Bill 7117, 61st Congress, 2d Session, relating to an increase in the Corps of Engineers as reported out by the Military Committee, are misunderstood by you, and with the sanction of the Chief of Engineers a memorandum has been prepared and a copy is inclosed in explanation of the changes made in the original bill, and to show that such changes, in themselves at least, cannot be properly considered to have so modified the character of the bill as to properly render it obnoxious to the Engineering profession.

Inasmuch as the changes made and the form of the bill reported out by the Military Committee are in the form recommended by the Secretary of War, Chief of Staff, and Chief of Engineers, any charge of tinkering the bill to accomplish certain ends and converting it into a farce must be at the doors of the officials named as well as at the door of the Military Committee. The Chief of Engineers is unwilling to believe that Engineering News intended making any such general charges.

The Chief of Engineers holds certain opinions based on his knowledge of facts and experience, and so far as his connection with the bill in question goes, he has been open in his expression of his views, and regrets any controversy which would tend to raise in the minds of the Engineering profession the thought that an effort is being put forth to disguise actual intentions and gain something by subterfuge.

Very respectfully,

A. MacKenzie,
Major-General, U. S. Army, retired.

Washington, D. C., April 11, 1910.

MEMORANDUM RELATING TO EDITORIAL IN ENGINEERING NEWS OF APRIL 7, 1910, CONCERNING "THE BILL TO INCREASE THE CORPS OF ENGINEERS, U. S. A."

The editorial on pp. 405-6, Engineering News of April 7, 1910, places a wrong interpretation upon the changes recommended by the Military Committee of the House of Representatives, so far as such changes affect the question of appointments from technical schools. The new form recommended by the Committee may be considered more favorable for such appointments than the original form.

The original Bill only covered the additional 60 officers, and when vacancies created by the Act might be once filled, the present law requiring all vacancies to be filled from graduates of the Military Academy would again come in force. As modified by the Military Committee, the present organic law is repealed and the provisions for appointments cover all future vacancies. The words "selected as heretofore" omitted by the Committee had no bearing upon the question of civilian appointments, referring to the long established custom of selecting for assignment to the Corps of Engineers only graduates recommended for such assignment by the Academic Board. Again the omission of the transfer clause, on the recommendation of the Chief of Engineers on account of understood objections by the engineering profession and Chief of Staff, which the Chief of Engineers believed to be well taken, removed one of the methods of filling vacancies from the Army.

The changes in the form of the Bill were made by the Committee upon the recommendation of the Chief of Staff and the Secretary of War, acquiesced in by the Acting Chief of Engineers, and, as before stated, the recommendations were not based upon any thought of limiting civilian appointments or changing the character of the Bill in that regard. Such changes mainly resulted from the claims presented by the Chief of Staff—the justice of which could not be disputed—that owing to the limited number of graduates and the desirability of assigning a greater number to other branches of the Army, the number assigned to the Engineers should be limited to what may be termed its fair quota, which quota, it may be stated, would be considerably below the number which have annually been assigned to the Engineers for a number of years back.

The statement in the article that the Bill as it now stands is a farce, that it is too evident that those who have tinkered the Bill in committee have been much more concerned in retaining a West Point monopoly than in promoting real efficiency, is certainly based on a misunderstanding of the changes made; the so-called tinkering resulting from the recommendations of the Chief of Staff and the Secretary of War, with a view, as understood, of accomplishing just the opposite results from that claimed in the article.

As to the absence of any provision relating to the compensation of Assistant Engineers, it can be stated that the original form did not contain any provision of that nature and no request for any provision fixing compensation was made, so far as known. In response to the direct question by a member of the Military Committee, whether the amendment suggested by the committee of Civil Engineers was intended to cover the matter of pay, it was stated by one member of the latter that it would only carry the pay that the Assistant Engineers had agreed to work for; and that while he could not speak from personal knowledge, he believed the pay now allowed was on the whole satisfactory for the service rendered; while it was stated by another member of the Engineer Committee that individually he thought "that if a civilian engineer is performing the same duty, carrying the same responsibility, subject to the same burdens, so to speak, that a regular officer of the Corps is carrying, he should have same compensation," but it was not claimed that such requirement was covered by the proposed amendment.

The Chief of Engineers is probably responsible for the use by the Committee of an extract from the Engineering News of Jan. 27, 1910, and that such use results in a protest from the paper is regretted. The extract was one of a number presented bearing upon the present system for carrying on River and Harbor works, which system, as well as the Bill itself, it was understood the article in question supported in preference to any of the several other systems before Congress for action. The other matters treated of in the article were, in the opinion of the Chief of Engineers, covered sufficiently in Sec. 4 of the original Bill, and, in addition, it was understood that such other points would be otherwise presented to the Military Committee.

The article of Jan. 27, 1910, was understood to be an indorsement of the Bill as originally presented, with a suggestion of the addition of a section placing limits as to age and experience upon those placed in charge of work, etc. Excepting possibly the omission of the proposed additional section, it would appear the bill in its new form should receive, from the Engineering News, even more commendation than did the original measure.

As regards the desired additional section, the one given in the article of Jan. 27 was not presented, so far as known, to the Military Committee; a substitute was, however, submitted by the Committee representing the American Society of Civil Engineers. It is believed the record of the hearing presents quite plainly the certain difficulties which would have resulted from the adoption of the proposed substitute and exhibits in effect the reasons of the Committee for not accepting it, but retaining in preference the section in its original form which will permit the Chief of Engineers to act justly and equitably as regards duties, responsibilities and compensation.

[In order that our readers may judge for themselves as to the merits and demerits of the bill

referred to, we print it below as reported to the House on March 23 from the Committee on Military affairs.—Ed.]

A BILL TO INCREASE THE EFFICIENCY OF THE ENGINEER CORPS OF THE UNITED STATES ARMY.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the commissioned force of the Corps of Engineers of the United States Army shall consist of 1 chief of engineers, with the rank of brigadier-general, 15 colonels, 22 lieutenant-colonels, 51 majors, 60 captains, 56 first lieutenants, 43 second lieutenants, and one chaplain: *Provided*, That the increase provided for in this Act shall be extended over a period of five years, as nearly as practicable, and that the original vacancies created by this Act shall be filled by the promotion in each fiscal year of not more than one lieutenant-colonel to be colonel, two majors to be lieutenant-colonels, three captains to be majors, four first lieutenants to be captains, and two second lieutenants to be first lieutenants.

Sec. 2. That vacancies in the grade of second lieutenant in the Corps of Engineers shall hereafter be filled, as far as may be consistent with the interests of the military service, by promotions from the corps of cadets at the United States Military Academy; Provided, That vacancies remaining in any fiscal year after the assignment of cadets of the class graduating in that fiscal year may be filled from civil life as hereinafter provided: And provided further, That the proportion of any graduating class assigned to the Corps of Engineers shall not be less than the proportion which the total number of officers authorized at date of graduation for that corps bears to the total number of officers authorized at same date for all branches of the army to which cadets are eligible for promotion upon graduation, except when such a proportionate number is more than the number of vacancies existing at date of graduation plus the number of retirements due to occur in the Corps of Engineers prior to the first day of the following January.

Sec. 3. That to become eligible for examination and appointment, a civilian candidate for the appointment as second lieutenant must be an unmarried citizen of the United States between the ages of 21 and 29, who holds a diploma showing graduation in an engineering course from an approved technical school, and is eligible for appointment as a junior engineer under the Engineer Bureau of the War Department. Selection of eligible civilians for appointment, including term of probation, shall be made as the result of such competitive examination into the mental, moral, and physical qualifications, and under such rules and regulations as shall be recommended by the Chief of Engineers and approved by the Secretary of War.

Sec. 4. That whenever it shall be necessary, in order to properly prosecute works of river and harbor improvement, the Chief of Engineers is authorized to detail for duty in charge of river and harbor districts, or as members of boards of engineers any assistant engineers in the employ of the Engineer Bureau of the War Department.

Sec. 5. That the officers of the Corps of Engineers, when on duty under the Chief of Engineers connected solely with the work of river and harbor improvements, may, while so employed, be paid their pay and commutation of quarters from the appropriations for the work or works upon which they are employed.

Sec. 6. That all laws and parts of laws inconsistent with the provisions of this Act be, and the same are hereby, repealed.

[Inasmuch as reference is made in the above letter and memorandum to the position taken by a Committee of the American Society of Civil Engineers with reference to the bill, we submitted a proof of the foregoing to that committee and have received a reply which we print below.—Ed.]

Sir: Referring to articles in the Engineering News of Jan. 27 and April 7, and to your letter of April 15, all in regard to the pending bill for the increase of the Engineer Corps of the Army, it may be of interest if some account be given of an effort made by Civil Engineers to secure better recognition of those employed as Assistant Engineers on river and harbor works.

It was the opinion of many of those most interested that the bill as drawn would not effect this to any great extent; but an amendment was drafted which was published in your issue of Jan. 27, and the bill in connection with the amendment received your hearty approval.

At a meeting of civil engineers called hurriedly in this city a few days after the annual meeting of the American Society of Civil Engineers in January, a committee, consisting of Mr. Charles MacDonald, Chairman, and Messrs. Frederic P. Stearns, Wm. H. Burr, Samuel Whinery and Alfred Noble, was appointed to endeavor to secure in the new bill more adequate provision for civil engineers employed on River and Harbor Works. The action thus hurriedly taken was approved and endorsed subsequently by the Board of Direction of the society.

The committee thus appointed held several meetings and the subject was discussed to some extent with officers of the Corps of Engineers, with the result that it was thought best to modify the first draft of the suggested amendment to the bill (See Engineering News, Jan 27), and the modification of the bill which it was finally decided to ask for was incorporated in a new draft of Section 4, as follows, the modifications being italicised:

Sec. 4. That whenever it shall be necessary *or advisable* in order properly to prosecute works of river and harbor improvement, the Chief of Engineers is authorized to *appoint or* detail for duty in charge of river and harbor districts, or as members of boards of engineers, any assistant engineers in the employ of the Engineer Bureau of the War Department; *Provided, that assistant engineers so appointed or detailed shall, while so engaged, have the relative grade of Captain or Major in the Corps of Engineers, to be determined by the Chief of Engineers, and provided further, that neither assistant engineers nor officers of the Corps of Engineers shall be detailed in charge of river and harbor districts or divisions until they have had at least five years' experience on river and harbor work.*

It will be noted that in the above draft the required period of service as assistant before assignment to the charge of river and harbor districts was five years instead of the period of eight years mentioned in the original amendment published in Engineering News, Jan. 27, and also that the requirement in regard to appointments on boards was omitted.

The committee requested a hearing before the Committee on Military Affairs of the House of Representatives, which was granted March 9, following a hearing of officers of the Corps of Engineers and followed by a hearing of Gen. Bell, Chief of Staff of the Army. At or after these hearings the bill was modified somewhat to conform to the wishes of the Chief of Staff, but none of the suggestions made by the committee of Civil Engineers was acted on favorably, and Section 4, the only one which that committee sought to have modified, stands exactly as before the hearings.

After returning from Washington and obtaining a report of the hearings (the committee of Civil Engineers had not heard General Bell) it was thought advisable by the committee to prepare a statement and lay it before the House Committee on Military Affairs. A copy of this will be published in the Proceedings of the American Society of Civil Engineers for April, on or about the 27th inst. In the statement the features of the proposed amendments are discussed in a general way and the statement may be summarized briefly.

It was explained that the additional words "or advisable" in the first line and the words "appoint or" in the second or third line following were intended to increase the power of the Chief of Engineers to assign civil engineers serving under him to more responsible duties, and remove any possible limitation of his authority which might result from a narrow legal interpretation of the word "necessary." The provisos were added to remove a grievance of 40 years' standing, which it is said cannot be remedied under existing laws. It was pointed out that the resulting condition was harmful both to the organization of the Engineer Bureau taken as a whole and to the public interests.

Prompted by the claim made, inferentially at least, of the advantage of military training in preparing men for the management of engineering work the committee pointed out the small share, comparatively, taken by Army engineers in the entire engineering work of the country, by far the greater part of which is organized and carried out by civil engineers, and mentioned two notable examples of such organization. One of these is in connection with the additional water supply for the City of New York of which the committee says "In respect of ability, integrity and devotion to duty this organization is not excelled by any other within our knowledge, military or civil." The other example mentioned by the committee is the Panama Canal, of which it is said that all the main features were completely organized and in successful working order before the Army Engineers took charge; this is followed by full acknowledgment of the admirably effective management of the work by the Army Officers since that time.

The endeavor to better the condition of civil engineers employed by the Army engineers has not been made in a spirit unfriendly to the Corps of Engineers; the great value of its services to the public was freely mentioned both in the hearings and in the statement. It is well known that the injustice inherent in the present system has long been recognized and regretted by many fair-minded officers of the Corps, but under existing laws they have been powerless to remedy it. The modification sought in the pending bill would enlarge the power of the Chief of the Corps to accord fair treatment to a class of engineers who constitute a majority of his engineer subordinates; even the matter of compensation is left wholly to him, not doubting that if proper authority be given, justice will be done. The only feature by which by any interpretation his authority may be regarded as limited is in regard to the assignment of inexperienced engineers to duties of great responsibility. The provision suggested is intended to remedy an evil of long standing for which the Army Engineers have not been responsible heretofore; if adopted the effect on the Assistant Engineers will certainly be encouraging and helpful and will conduce to a better feeling in this branch of public service. Can any good reason be given for retaining the power to be grossly unfair to the more experienced subordinates?

Before closing this letter we would call attention to the following extract from the remarks of the Chief of Staff before the Military Committee (he had been opposing the assignment of an unduly large proportion of cadet graduates to the Engineer Corps):

Now we are proposing in this bill, and on this we have agreed, that the Engineer Corps shall fare just the same as the rest of the Army; that the number of graduates it shall receive from the Military Academy shall be in proportion to the number of officers that belong to the Engineer Corps. . . .'

Now note the language of the bill as agreed upon by the Army representatives, quoting from Section 2:

And provided further, that the proportion of any graduating class assigned to the Corps of Engineers shall not be less than the proportion which the total number of officers authorized at the date of graduation for that Corps bears to the total number of officers authorized at the same date for all branches of the Army to which cadets are eligible for promotion upon graduation. . . unless the number so assigned would exceed the number of vacancies in the Corps.

Is this language consistent with the agreement mentioned by the Chief of Staff? Should not the word "more" be substituted for the word "less"? If this bill should become a law, there will be no legal limit to the number of cadets to be assigned to the Corps of Engineers from any graduating class, and the situation as regards admission to the Corps may continue precisely as at present.

But it was not the intention or desire of the committee of Civil Engineers to take up the question of the enlargement of the Corps, however desirable the introduction of engineers educated at other schools than West Point may be, but to make a very moderate suggestion toward removing in some degree the injustice suffered for nearly half a century by a class of engineers who have rendered valuable service and have contributed to no small extent to the high reputation of the Army Engineer Corps in the superintendence of river and harbor works.

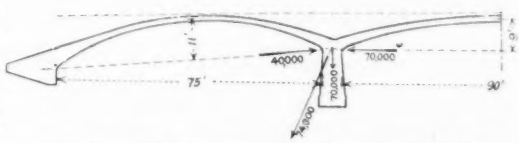
Very truly yours,
Alfred Noble,
Wm. H. Burr,
S. Whinery.

New York City, April 18, 1910.

The Failure of the Pugh Ford Arch Bridge.

Sir: In Engineering News, March 17, 1910, p. 323, a full account is given of a three-span reinforced-concrete arch bridge near Edinburg, Ind., which failed during high water under its own weight. This bridge had a middle span of 90 ft. with a rise of 9 ft. and two side spans of 75 ft. each. The elevation at the crown of the side span is 8.5 ft. more than at springing on the pier, but it is about 14 ft. more than at springing on the abutment. The effective rise of these side arches is then about 11 ft. instead of 8.5 ft., and herein lies a complete explanation of the failure of the bridge.

In the accompanying sketch the dead load thrusts of one foot width of these arches are given roughly. The longer arch with the smaller rise will of course have a



larger thrust than the others, and this unbalanced thrust will have to be resisted by the pier and the 75-ft. arch. The resultant of the forces per transverse foot on the pier is a force of 74,000 lbs. in a direction that does not strike the base of the pier. The pier could take about 10,000 lbs. of the horizontal component of this force, leaving about 20,000 lbs. of thrust to be taken by the arch. Such a force on this arch with its 16 ins. of depth at crown means about 5,000 lbs. per sq. in. of tension in the concrete. The concrete is not reinforced in the upper part at the crown and is in no condition to take more than a small fraction of this. The spandrel walls of this bridge must have been doing heavy duty before the collapse. It is a wonder that the bridge stood up any time after the centers were removed.

High water would reduce the stability of the pier because of its diminished weight due to submersion. The side arch, being unable to resist the excess thrust of the long span, would fail, and then the long span would drop, pushing the pier in deep water toward the 75-ft. span. The next pier, being relieved of the thrust of the 90-ft. span would get the full thrust of the other 75-ft. span and tilt over. This appears to be the sequence of events. Reinforced concrete is exonerated, but the design of arches in series is shown to need more care than this one had.

Yours truly,
Archy.

Pittsburg, Pa., March 21, 1910.

Sir: In Engineering News, March 17, p. 323, you give a full description of the wreck of a reinforced-concrete arch highway bridge over the Flat Rock River near Edinburg, Ind., and I beg leave to comment on one of the conclusions reached by the member of your editorial staff who has examined the bridge after the accident.

The failure of the structure was due to the undermining of the west pier by a flood of unusual height, and it is, if not expressly stated, at least implied in the article that the omission of the pile foundation which had been proposed in the plans prepared by the National Bridge Co., of Indianapolis, Ind., is the cause of said failure.

The 26 piles under the west pier provided for in the bridge company's plans would not have saved the structure. The west pier, according to these plans, was to have been built with a depth of 2 ft. 6 ins. below the bed of the river (whether this means 2 ft. 6 ins. below the surface of the river bed at the place the pier was located, or 2 ft. 6 ins. below the deepest place in the river bottom, is not stated), and the County Commissioners wisely concluded to carry the pier down to about 5 or 6 ft. below the bed of the stream. Yet, the river bed was scoured out to greater depth than the bottom of the pier. Therefore, had the change in the original plans not been made, the pier would have been supported, during a flood of great height, on the free ends of piles with a space of not less, in all probability a great deal more, than 3 or 4 ft. between the soil and the bottom of the pier. That in this condition the pier of a concrete arch bridge (of unequal length of spans, too), and with the pier, the whole structure was doomed, no competent engineer will deny.

The parallel case of the Peoria, Ill., bridge is cited in your article and sustains my view. In his testimony

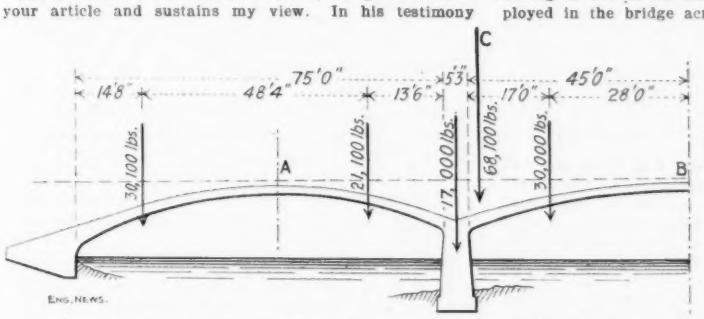


FIG. 1. VERTICAL REACTIONS ON ARCH AND PIER.

(published in Engineering News, May 13, 1909), Mr. Edwin Thacher distinctly states that the lack of protection of the piling of the Peoria bridge by permanent cofferdams has caused the failure of the piers. Mr. Thacher had not relied for the safety of the Peoria bridge on a pile foundation exposed to scouring.

Respectfully yours,

Carl Gayler.

900 Wainwright Bldg., St. Louis, March 21, 1910.

[The preceding communications were submitted to the National Bridge Co., who designed the bridge, and from that company we have received the following reply.—Ed.]

Sir: We beg to thank you for submitting to us for reply the communications concerning the Pugh Ford Bridge.

The analysis submitted by "Archy" is not correct. The pier supports the ends of two unequal spans; the resultant load cannot then rest centrally on the pier as assumed by "Archy," and by no possible arrangement can the resultant of all forces acting on the pier be made to pass through the center of the pier at the top as shown in his figure. This should have been obvious to anyone familiar with arch analysis, for it can be seen at a glance even from "Archy's" figure itself that the load on the pier must be eccentric, otherwise how could there be any difference of thrust between the two half arches arranged with substantial symmetry on the pier? The 70,000-lb. resultant of the weights on the pier does not lie on the center line of the pier as shown in his figure but is actually about 4 ft. to the right and is properly shown at *C* in Fig. 1 herewith.

"Archy" is in error also in assuming the thrust of the inclined arch at 40,000 lbs. in an inclined position without taking into account the component normal thereto. The thrust of the inclined arch is not 40,000 lbs. but 48,000 if assumed in the inclined position for compounding with vertical forces. A more satisfactory method of analysis would be to determine the *horizontal* thrust of the inclined arch against the pier, which is readily accomplished by assuming that the horizontal thrusts of the two parts of the inclined arch to right and left of crown, are equal. The horizontal thrust of the inclined arch will then be found to be 46,000 lbs. and an inclined component as shown by "Archy" will be 48,000 instead of 40,000.

Again "Archy" is in error in applying his analysis as he does to a reinforced-concrete arch supported on a reinforced pier, both carefully designed to resist the moments induced by eccentric loading. "Archy's" analysis belongs to the stone age, and if the arches had been built of stone with no reinforcement, as shown in Fig. 1, failure would have resulted. But these arches were balanced by providing a reinforcing member D (Fig. 2) along the pier and arch to resist the moment due to eccentric loading, and further by elevating the springing and thickening the haunch of the shorter span to cause it to overlap the longer span at E. The short span has a longer radius at the springing than the long span, although the contrary would be expected, and these features were incorporated for the express purpose of maintaining the balance of the arches. This method of balancing arches is no longer new, having been first employed in the bridge across the Wabash River at Peru, Ind., erected in 1905, and described in Engineering News March 29, 1906, p. 347, in which article this method of providing for unequal thrusts on high piers was analyzed and explained. In that bridge, spans of 85 ft. were balanced against 95 ft. spans on piers 6 ft. thick and 26 ft. above rock foundations. The method is also the subject of an application for patent which has been pending since Nov. 1, 1906.

"Archy's" analysis could apply only in case of two equal spans one much flatter than the other, and both arches hinged at three points. And in such a case entire reliance must of necessity be placed on the resistance of the mass of the pier, and an excessive live load on the first span would destroy the bridge by diverting the resultant from the base of the pier. Whereas in the reinforced structure as designed by this company, an excessive live load on the longer span increases the moments in the arch and pier, but may actually carry the resultant on the pier to the right, and on the side of safety. So, too, submergence of the pier in this structure moves the resultant load to the right tending to offset the loss instability of the pier. The structure is by no means as simple as "Archy" would have us believe, and there are in fact numerous features about the balancing of such reinforced arches that are entirely undreamed of by one who has not had actual experience with the structures themselves.

Before jumping to theoretical conclusions, it is usually wise to study the behavior of an actual structure. "Archy's" conclusions are not at all in accord with the facts in this case. The short span showed no signs of distress whatever and the spandrels were not even under stress, contrary to "Archy's" assertion that they "must have been doing heavy duty." The spandrels showed no evidence of tension at the crown and they transmitted no compression, for all of the expansion joints on the short spans were open and remained open. This point was carefully noted for it has long been a theory of this company that arch bridges should be built in unequal spans for efficiency, increased waterway, and enhanced appearance. Far from being carelessly designed, this bridge was designed with the greatest care to provide for the unequal spans, and in view of "Archy's" failure to even grasp the elements of the problem, his statement that "the design of arches in series is shown to need more care than this one had" is literally a boomerang.

It will be shown later that the resultant does fall properly within the base. The theory is, however, by no means as simple as "Archy" has assumed and before giving the analysis of the forces on the pier it may be well to explain the construction of this structure since methods that apply to stone arches may not be adequate in this case, as emphasized above by "Archy's" failure to recognize in the pier a member capable of resisting bending moments.

The bridge consisted of three arches of spans 75, 90 and 75 ft. and with end spans distorted to permit of high springings at piers for maximum waterway. The rise of the 90-ft. arch was 9 ft. from springing to intrados crown. The rise of the pier end of the 75-ft. arch was 8 ft. 5 ins. and of the abutment end 13 ft. 11½ ins. The pier was 5 ft. 3 ins. thick at springing with faces battered 1 in 15. The pier was designed for piling foundations and the contractor bid a lump sum for the bridge and 60 cts. per lin. ft. additional for piling. The Commissioners of the county in an endeavor to save the high cost of the piling, asked the contractor if the piling could be safely omitted. The reply was that the piling might be omitted with perfect safety provided the footings were carried to a sufficient depth to insure the foundations against scour, and named them a price of $5.25 per cu. yd. for additional concrete. This proposition was accepted by the Commissioners and the foundations were then placed at the depth required by the Commissioner's engineer.

The arches were concreted in longitudinal rings reinforced as shown in Fig. 2. The spandrels were built continuous from springing to springing only, ending at a vertical expansion joint over each springing, at abutments and piers. There were thus six expansion joints on each side of the roadway. The part of the spandrels above the arches at the pier, and between the expansion joints, was concreted last and was merely a filler unable to transmit compression or bending from the pier. All of these operations were conducted in accordance with the method outlined in Engineering News of March 29, 1906, above referred to.

There was, therefore, no possibility of any compressive stress being transmitted through the spandrels. The expansion joints at the abutments were open about ⅛-in. and this fact was emphasized by the grading contractor for the county who reported that the bridge was cracking when the joints at the abutments had opened properly. An engineer was sent by the company to investigate and a careful study of the expansion joints was made. The joints on both sides of the piers had also opened properly, those on the side of the long span being slightly wider than on the short span side, as was to have been expected. But no evidence whatever of any compression or tension in spandrels was ever detected. And as for a stress of 5,000 lbs. per sq. in. as stated by "Archy," any one at all familiar with concrete knows that such a tensile stress in concrete is wholly impossible and exceeds by 100 times, the allowable stress. The concrete was not reinforced in the upper part at the crown and the analysis will show that no such reinforcement was needed. Reinforcing the pier, 5 ft. thick, is a much more efficient way of resisting the moments due to unequal thrusts than by reinforcing the extrados of an arch 16 ins. thick. And the practice quite common among engineers of reinforcing an arch along the extrados at the crown where it can by no possibility be in tension, *and with no restraining stirrups* to prevent the steel from buckling, is indefensible.

This company has designed upwards of 3,000 concrete arches that have been erected with the reinforcement as shown in Fig. 2. Many of these are in multiple spans of unequal length balanced on slender piers and in many of them the eccentricity of span is greater than in the Pugh Ford Bridge. The bridge had stood through six months of winter and had been subjected to one higher flood than that in which it collapsed. The up-stream nose only of the west pier was undermined to a depth of 12 ft. below mean low water, caused undoubtedly by lodgement of debris against the pier, and in fact nearly all cases of undermining of piers are traceable to such a cause. The undermining did not extend the entire length of the pier and was not due to scour from insufficient waterway for the high water level was but 2 ft. above the pier springings and there was no evidence of any damming back of the current. Had piling been used the undermining would undoubtedly have been prevented to a large extent by their impediment to the current.

The photographs of the collapse show that "Archy's"

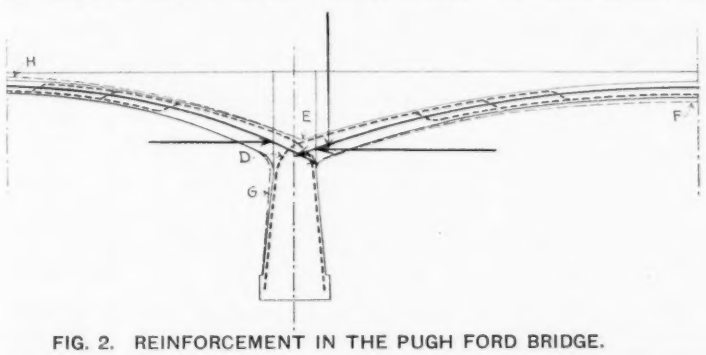


FIG. 2. REINFORCEMENT IN THE PUGH FORD BRIDGE.

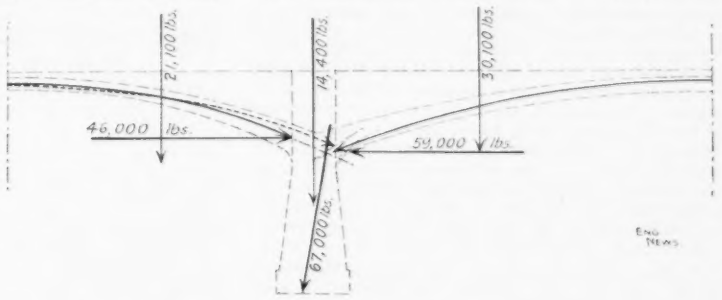


FIG. 3. THRUSTS AT INTERMEDIATE PIER.

theory is wholly untenable. The pier fell up-stream. How explainable if "Archy" is right? A portion of the 90-ft. span 10 ft. in length still remains solidly attached to the undermined pier. How could this be explained if the failure was due to overturning of the abutment from unbalanced thrusts? After the two west spans had completely collapsed, the east 75-ft. span remained standing over 24 hours supported only by its slender pier. If this pier could sustain but 10,000 lbs. as alleged, and the arch exerted a thrust of 40,000 lbs. as alleged, but in reality 46,000 lbs., what supported the arch during this 24 hours? Apparently "Archy's" analysis will not even apply to a single span, much less to three.

In the above, too, is a complete answer to Mr. Gayler's criticism. If the structure had been supported on piling as designed with no provision whatever for any lateral thrust at base of pier, as for example in case the entire foundation had been scoured away from the piling, failure might have resulted. It is however by no means unusual to see piling used for supporting falsework and carrying upwards of 15 or 20 tons with an exposure of 10 or 15 ft., and their exposure under this pier would not necessarily have spelled failure since the piling was abundantly able to support the load alone. But this contingency is too remote for consideration. Piling is used in pier foundations to prevent undermining as well as to increase the bearing. If only for the latter purpose as intimated by Mr. Gayler, of what use to employ piling at all. For obviously if foundations must be carried to such a depth or to such bearings as will never undermine, then better omit the piling altogether and expand the footings the small amount necessary to secure adequate bearing. The design was made on information given by the County Engineer and the piers were extended 5 ft. deeper than shown on his plans for a steel bridge. Undoubtedly the same end would have come to the steel bridge and in fact the flood that destroyed this $8,000 concrete bridge washed away over $200,000 worth of steel bridges. Had the contractor been left free to build on the design as originally planned it would undoubtedly have been properly erected under our supervision for the plans were fully guaranteed with surety company bond.

Sheet piling about the pier supported on piling, would not have increased its stability materially when scoured to the depth assumed by Mr. Gayler. The only satisfactory way to make a bridge flood-proof on gravel foundations is by the use of a flood-proofing pavement and this would have cost some $2,000 additional in this case and was therefore not considered.

To return now to an analysis of the forces acting on the structure, Fig. 1 shows the loads supported by the pier. The pier carries that part of the short arch to the right of *A* amounting to 21,100 lbs. for 1 ft. transversely and having its center of gravity 13 ft. 6 ins. to the left of the pier. It carries half of the long arch amounting to 30,000 lbs. 17 ft. from the pier. And at low water, the weight of the pier itself is 17,000 lbs. The resultant of all of these weights is 68,100 lbs. at *C*, about 18 ins. to the right of the pier face.

No analysis of the stresses in the structure can be made without starting with the assumption that the pier is eccentrically loaded and stressed. The resultant cannot pass through the center of the pier as assumed by "Archy." The left of the pier is in tension; the right in compression. There must result at once a deflection of the top of the pier towards the left with a corresponding flattening of the 90-ft. arch. Since the base of the pier remains fixed, its top not only tends to move towards the left but also to rotate about the base, producing tension along the left face of the pier and along the extrados adjacent the pier, of the long arch, with tension along the intrados at the crown. For the present we will assume that the short span plays no part except to exert its normal thrust of 46,000 lbs.

No very accurate analysis is possible. The elastic theory cannot be applied to the arch for two of its basic assumptions are upset, that is, the abutment of the arch has both lateral movement and rotation. But it will be apparent at once that if the bridge of Fig. 2 is distorted by the eccentric load into the position shown in exaggerated form by the dotted line *FG*, the arch must be in compression along the intrados near the pier and along the extrados over the crown. The line of thrust in the arch will therefore *approximate* the position shown by the full line in Fig. 3. Assuming this line of force in the extreme position that it may assume without exceeding the allowable stresses in concrete and steel, its horizontal component is 59,000 lbs. acting on the pier just above the springing. If we assume that the short arch is not distorted but that its line of thrust follows its center line, it will be indicated by the full line on the left with a horizontal component of 46,000 lbs. But this line of thrust may be diverted to the edge of the middle third without causing any tension whatever, as shown by the dotted line, and in this event and because of the excessive thickness of haunch of the short arch, the two lines of thrust of the two arches meet outside of the pier on the right and the horizontal thrust of the short arch rises to 51,000 lbs. It might be, however, that safe stresses in the long span would be exceeded before any distortion would occur in the short span. Hence this analysis considers only the normal condition of that arch.

These two lines of thrust must now be compounded with the weight of the pier itself which, when completely submerged, is 14,400 lbs. The resultant of these forces is 67,000 lbs. approximately as shown in Fig. 3, under the most unfavorable assumptions.

Respectfully yours,

National Bridge Company.

Indianapolis, Ind., April 11, 1910.

Blast Furnace Slag as Concrete Aggregate.

Sir: Referring to your inquiry in Engineering News, March 24, 1910, p. 347, regarding information of experiences in the use of blast furnace slag for concrete aggregate, I take pleasure in sending you a few references on this subject, which I hope will serve your purpose.

Proceedings of the National Association of Cement Users, Jan., 1906, v. 2, p. 27.

> Interesting paper by S. E. Thompson, treating of effects of different aggregates upon the strength of mortar and concrete; principles for selecting stone, sands; testing formula for calculating strengths of mortars, etc. Discussion by Cummings, etc., p. 38.

"Mining Reporter," July 4 and 18, 1907, p. 9 and p. 54.

> Results of experiments made by H. J. Kesner and F. W. Doolittle at the University of Colorado with sandstone and two varieties of blast furnace slag. One of the latter gave strength values which compared favorably with the sandstone concrete. Tables of results of tests.

"The Surveyor," London, Jan. 8, 1909, v. 35, p. 32.

> Report of the special commission on concrete aggregates of the British Fire Prevention Association, giving specification of artificial and natural materials for aggregates. Blast Furnace Slag: Blast furnace slag for use as a concrete aggregate to be obtained and selected from pig iron smelting furnaces (to the exclusion of basic slag) to be of porous quality, to be washed to remove dust and sulphur, to be without free lime and not to contain more than (-) per cent. of sulphur (Allowable amount of sulphur the subject of further consideration).

The above references appear to give the general conditions met with in ordinary construction.

Very truly yours,

J. Louis Jacobs.

90 Wabash Ave., Chicago, March 28, 1910.

Notes and Queries.

Through an inadvertence the article on "Concrete Piles" in our issue of April 7, 1910, p. 411, was credited to the report of the Committee on Masonry of the American Railway Engineering and Maintenance of Way Association when it should have been credited to the Committee on Wooden Bridges and Trestles of the same Association.

The Proposed Enlargement of the Water-Supply of Baltimore, Md.

By ALFRED M. QUICK,* Assoc. M. Am. Soc. C. E.

Mr. John R. Freeman and Mr. Frederic P. Stearns have completed their investigation in regard to the enlargement and improvement of the Baltimore water-supply, on which they have been engaged for the past year, and have presented their report.

They were engaged as consulting engineers for this work by Mayor Mahool of Baltimore in November, 1908, under the authority of a city ordinance, but at the Mayor's request did not commence their work until the spring of 1909. Their report has been accepted by the Mayor and the Water Board, and, as a $1,000,000 appropriation from an already authorized loan of $5,000,000 is available for the work this year, the Water Board has directed the Water Engineer to proceed at once with the construction of the most important improvements recommended.

The report of these engineers is very exhaustive and undoubtedly of sufficient value and general interest to be published in full, but it is so comprehensive that only the general conclusions and recommendations can be given here.

A review of the general features of the present water-supply system of Baltimore and of the conditions which led up to the engaging of these engineers is essential to a clear understanding of the matter.

The water-supply of Baltimore is now derived from Jones Falls and the Gunpowder River which flow into arms of Chesapeake Bay near the city. On Jones Falls water is impounded in Lake Roland at a point about four miles from the city and is conveyed through a conduit, about 5 × 6 ft. in dimensions, to two large receiving reservoirs in the city from which part of it flows by gravity to the Middle Service area and the balance is pumped to the upper or highest service area. On the Gunpowder River water is impounded in Loch Raven at a point about seven miles from the city and is conveyed through a tunnel 12 ft. in diameter to two large receiving reservoirs in the city from which part of it flows by gravity to the Low Service and the balance is pumped to the High Service district. About five-sevenths of the daily consumption is taken from the Gunpowder River and two-sevenths from Jones Falls. The drainage areas of these two rivers above the impounding reservoirs is about 308 square miles for the Gunpowder and 40 square miles for Jones Falls. The drainage area of the latter is by far the most thickly populated of the two and is being built up to a considerable extent with suburban development.

The present method of supplying the city from these sources is to take only the clear water of the streams and to draw on the clear storage reservoirs in the city when the streams are muddy.

The city has for some time past faced the necessity of increasing and improving its water-supply. This necessity first became noticeably apparent in the very dry year of 1900, when the flow of the sources of supply dropped to a point perilously near the consumption. It was emphasized in the immediately succeeding years by the approximate exhaustion of the comparatively large available clear water storage capacity in the city during some periods of muddy water in the sources of supply. It has been still further emphasized by the experience during the unusually dry period of last year, when the total flow of the sources of supply dropped for a short time to about 12,000,000 gals. a day less than the consumption.

Although the experiences of 1900 and the immediately succeeding years referred to demonstrated the urgency of the situation it was not until the year 1904 that conditions arose which enabled the necessity to be so forcibly presented as to secure some action by the city. The great fire of that year awakened public spirit and inspired a determination to secure such public improvements as would put the city abreast of the times.

The Public Improvement Conference of representatives of all commercial, improvement and labor organizations, which was called immediately after the fire, determined to include the enlargement and improvement of the water-supply as a part of a general scheme of public improvements for which loan enabling acts should be obtained. This Conference decided that the improvement of the water-supply should include the construction of a great impounding reservoir on the Gunpowder River above Loch Raven, and the abandoning of Jones Falls as a source of supply, and also decided that a loan of $5,000,000 should be obtained for that purpose.

Consequently an Enabling Act for $5,000,000 was prepared and introduced into the State Legislature of 1906, providing for the building of such a reservoir and improvements of any nature which might be considered. It was defeated, however, through the opposition of Baltimore County residents and officials and of private corporations whose interests would have been effected by the proposed improvements. The Act was again introduced in the Legislature of 1908, after practically all the points at issue had been adjusted or compromised, and was passed at that session. It was approved at the polls in the regular election of November, 1908, and at about the same time the city ordinance was passed authorizing the appointment of two eminent consulting engineers, under the authority of which the Mayor selected Mr. Freeman and Mr. Stearns.

As considerable opposition developed to the plan of building a large reservoir on the Gun-

*Water Engineer, Baltimore, Md.

powder River the engineers were asked to consider the question without any regard to past legislation, to investigate all possible sources of supply, to pass judgment on all plans and schemes that had been suggested, and to recommend the best thing to do regardless of any such plans. During the course of the investigation it became evident that the sanitary conditions of the two present sources of supply, the turbidity of the Gunpowder River, and the clarification and purification of the supply from the Gunpowder River, were elements of vital importance. Consequently, at the request of Messrs. Freeman and Stearns, Mr. Geo. C. Whipple was first engaged by the Water Board to make the sanitary and turbidity investigations, and subsequently Mr. Allen Hazen was engaged to investigate and report as to the clarification and purification of the Gunpowder River supply. Many examinations of and experiments with soils and turbid water samples were made by Mr. Whipple in New York and under his direction by employees of the Water Department in a temporary laboratory at Loch Raven.

The conclusions of Messrs. Hazen and Whipple are incorporated in the report of Messrs. Freeman and Stearns, and the final recommendations of Messrs. Freeman and Stearns are as follows:

That a new dam be built on the Gunpowder River at Loch Raven about 2,200 ft. above the present dam at an elevation of 237 ft. above mean tide, or 67 ft. higher than the present dam, controlling a reservoir of about 21 billion gallons capacity.

That a 12-ft. tunnel about 6,340 ft. long be constructed to a junction with the present Gunpowder tunnel at a point in Mine Bank Run valley about 4,000 ft. from the present dam and gate house.

That at that point in Mine Bank Run valley, coagulation works and a sedimentation basin be constructed having a high water elevation of 235 ft. above mean tide, coagulation by chemicals to be used only when the water is muddy. The consulting engineers' suggested plan for these works shows a coagulation basin of about 8,000,000 gals. capacity and a settling basin of about 300,000,000 gals. capacity.

That slow sand filtration works be constructed immediately on land near Lake Montebello where the present Gunpowder tunnel ends for filtering all of the water required by the city now and for ten years to come; the filters to have a net filtering capacity of 20 acres, a nominal capacity of 6,000,000 gals. per acre, or 120,000,000 gals. per day, and a high water elevation of 220 ft. above mean tide, all as recommended by Mr. Hazen.

That a covered filtered water reservoir be constructed adjoining the filters, having a capacity of 15,000,000 gals. and a high water elevation of 218 ft. above mean tide, as recommended by Mr. Hazen.

That a steel pipe 9 ft. in diameter be laid from the filtered water reservoir near Lake Montebello about 5,900 ft. to a point near Lake Clifton, with connections from the lower end of this pipe to the existing distribution pipes near Lake Clifton and to other distribution pipes of the Middle Service in the city; these connecting pipes comprising about 1,300 ft. of 7-ft. steel pipe and about 2,200 ft. of 60-in. and 10,300 ft. of 48-in. cast-iron pipe.

That the pressure in the Low Service district be increased by consolidating it with the Middle Service district and both be supplied directly from the filtered water reservoir, which will have a working elevation practically the same as that of the present Middle Service Reservoirs.

That the present small high service reservoir in Druid Hill Park be covered and used for storing filtered water for that service.

That the use of water from Jones Falls be discontinued.

And that the present reservoirs, Montebello, Clifton, Hampden and Druid, be retained for emergency supply.

They estimate that the total cost of these improvements would be about $6,600,000.

With these recommendations carried out the method of supply will be changed from an intermittent feeding from the two sources only when the water is clear and relying for purification entirely on the clear water storage interposed between the impounding reservoirs and the consumers, to a continuous supply from the larger and better source only, through a settling basin and filters. It will not only increase the pressure over the greater part of the mercantile, shipping and manufacturing sections of the city by about 20 lbs., but it will place an available reserve storage capacity of from 7 to 10 billion gallons of water at one end of a 12-ft. tunnel and large connecting pipes, at an average elevation of about 180 ft. above three-fifths of the city at the other end of the tunnel and pipes. It will provide an absolutely clear and pure water-supply for the whole city, with no additional expense except for a slight addition to the filter plant, of about 135,000,000 gals. a day, or nearly twice the present daily consumption, and at a very low cost compared with what other cities have been compelled to pay for equivalent benefits in a greater and purer water-supply.

As the present authorized loan for the work is only for $5,000,000, all of the improvements recommended by the Consulting Engineers cannot be undertaken at once. In view of this fact the engineers suggest that the construction of the coagulating and settling basins might be deferred, as it will probably only be a few days in each year that the water in the big lake will be so muddy as to necessitate the use of coagulant before filtering. They also suggest the possibility of deferring the covering of the High Service Reservoir. They regard both of these features, however, as very important and necessary construction to insure the city's having at all times an absolutely clear and satisfactory water.

It has been found since the engineers' report was sent in that a very considerable expense can be saved in the matter of land purchases which was not previously known. The Water Board have therefore directed that the dam and tunnel, filter works and filtered water reservoir be constructed at once. If as contracts are let and work proceeds it is found that all of the improvements recommended by the Consulting Engineers except the coagulating and settling basins and the covering of the High Service Reservoir can be completed approximately within the $5,000,000, then those two improvements may be deferred for a number of years; but if it is found that the improvements mentioned that the Water Board have directed to be installed at once cost so much that not enough would be left of the $5,000,000 to construct the pipe lines to connect the filtered water reservoir with the distribution system, and that therefore it will be necessary to have additional funds for the latter purpose anyway, then an enabling act for an additional loan large enough to cover the cost of the coagulating and settling basins and covering the High Service Reservoir, as well as the cost of the connecting pipes, will probably be asked for from some subsequent Legislative Assembly.

The preparation of detail plans for the work and supervision of the construction will be done by the Water Department under the direction of the Water Engineer. For this purpose a new division of the department has been organized called the Gunpowder Supply Improvement Division, with Assistant Engineer Emory Sudler in charge.

Recovery of a Large Fire-Sealed Area of a Coal Mine Through Investigation With Oxygen Helmets.*

By R. Y. WILLIAMS.†

The recent recovery of an area of 40 acres which had been sealed off for 75 days on account of fire in the Majestic mine in the southern coal field of Illinois was made possible by investigations conducted with the aid of oxygen helmets. The Majestic mine, operated by the Majestic Coal & Coke Co., is located five miles east of Du Quoin near the western boundary of Franklin Co., Ill. This mine has a capacity of 2,000 tons per day of eight hours, and is developed in the No. 6 or "Blue Band" seam, which at this location is about 9 ft. in thickness, and lies under a cover of 400 ft.

*Abstract from an article in "The Mining World," April 2, 1910.

†U. S. Geological Survey.

The mine is worked on the room-and-pillar system, the main entries running east and west and the butt entries north and south. Rooms on 50-ft. centers are driven east and west off each pair of butts, and are allowed to hole through into the rooms of the adjacent entries. It is customary in the advancing workings, to leave up 2½ ft. of top coal as roof, to rob the room pillars as soon as the rooms are completed and to take the top coal in the retreat.

This is not considered an especially gaseous mine, but the methane factor has to be carefully watched. The coal is rich in volatile matter and is highly inflammable.

Origin of the Fire.

At 9 o'clock on the evening of Sept. 20, 1909, the shotfirers shot a charge of black powder in the top coal of room No. 27, on the second south off the main east entry. In an unknown manner, this blast set fire to the coal, and started what proved to be a serious fire, that was not discovered until 2 o'clock on the morning of the 21st, five hours after the shot had been fired. During the balance of the night, continued effort was made to fight the fire with water, but as the attempt to control it was unsuccessful, it was decided at 8 o'clock in the morning to seal it off. To accomplish this, stoppings were quickly built of two thicknesses of 1 × 12-in. shiplap boards, made tight with gypsum products and woodfiber plaster.

At 4 o'clock that afternoon, the building of the stoppings had advanced until it was considered that the fire was under control, but it was 4 o'clock on the morning of the 22d before the sealing was completed. Then the room-necks on the first south off the main east were bratticed, in order to force air along the line of fire-stoppings in the crosscuts between the first and second south entries and thus to prevent the accumulation of bodies of marsh gas. This enclosed the four south entries off the main east, and also the rooms thereon—an area approximating 40 acres, and one that required the building of 29 fire-stoppings.

Investigation by Helmet Men.

Naturally, the sealing off of this large territory containing about 60 working places, occasioned a serious curtailment in the production of the mine, and the filling of the enclosed area with methane presented a constant danger to the miners. Accordingly, on Dec. 4, 74 days after the origin of the fire, James M. Webb and the writer, acting on the invitation of the Majestic Coal & Coke Co., arrived at the mine with the rescue apparatus from the Urbana Mine Rescue Station.

After the apparatus had been unpacked and charged, a number of mine bosses and company men were trained on the surface in the use of the oxygen helmets. The stoppings surrounding the fire region were found to have been carefully built and well plastered; but in a number of instances the plaster had dried and cracked, permitting leakage. A bottle sample of the air in the fire-sealed area, taken from one of the stoppings through an iron pipe, showed the following:

Carbon dioxide	3.6%
Oxygen	5.6%
Carbon monoxide	.01%

Unfortunately the apparatus for the quantitative analysis of methane was broken in transit, and no accurate determination of this gas could be made. But careful tests with a Wolf safety lamp indicated that the mixture was explosive when mixed with air—a fact further suggested by the above analysis which leaves 11% of oxygen unaccounted for.

At this point the plan of campaign adopted included (a) the reversal of the fan, in order that the gas when moved should be exhausted out the air shaft, leaving the hoisting shaft, pump room, stables, and main entries on the intake of the air, and (b) the building of an airlock in an entry crosscut as near the point of origin of the fire as possible in order that an inspection of this important place could be made as easily as possible, with the aid of the helmets, and with the admission of the least possible amount of fresh air. The airlock consisted of two board stoppings 8 ft. apart with a door built in the outside stopping. The building of the airlock occupied the remainder of the afternoon of Dec. 4.

The next morning a sudden drop in the barometer made it advisable to postpone the work until afternoon. Shortly after noon two men wearing helmets, and carrying electric safety lamps, entered the airlock and made a door in the inside stopping. After this was completed, helmet-men made thorough inspections of rooms Nos. 27, 28 and 29. The reports of all these examinations showed no fire, no smoke, and no heat; but indicated a very heavy fall of roof in room No. 28. The course of the ventilation at the time of the fire had carried the heat and flame from room No. 27, through the last crosscut between rooms Nos. 27 and 28, into room 28, occasioning the heavy fall just mentioned.

In spite of the reported absence of heat, the heavy fall in room No. 28 indicated a point of danger from a buried fire, considering the known manner in which fires had continued for long periods in sealed areas. It was therefore deemed unsafe to open the fire-sealed area in such a manner as to restore ventilation to its usual course, because of the following dangers:

(a) Hundreds of thousands of cubic feet of explosive gas would be passed over the fall in room No. 28.

(b) The ventilation would fan a smoldering fire into a blaze.

(c) An explosion would take place if the explosive gas came in contact with the flame.

(d) It would be a long time before this body of gas could be moved; and in case the fire was revived, it would be a long time before men could safely enter and begin the work of cleaning up the fall and fighting the fire.

Method of Recovery.

In order to exhaust this body of gas from the fire region without passing too much gas over the heavy fall in room No. 28, the following steps were taken in order of their enumeration:

1. The room-neck brattices along the first south entry were made tight enough to pass all the air needed along that entry.

2. The stopping on the extreme south end of the fire-sealed area was removed.

3. A canvas curtain was hung across the first south entry, immediately south of the crosscut containing the airlock.

4. The stopping at the extreme north end of the fire-sealed area was removed.

5. The doors of the ock were opened, allowing ventilation to enter, to split as soon as it had entered the fire region, and to travel part going north and part south.

This was begun at 9 o'clock in the evening of Dec. 5. Dec. 6, the rooms were inspected (this time without helmets) beginning at 5 o'clock in the morning. The indications were that there was a certain amount of heat making over the heavy fall in room No. 28. The top coal which had fallen 150 ft. back from the slate fall was thrown off the track, and work started loading out the slate, a matter of some 500 tons.

Shortly after this work was well under way, smoke was seen coming from the heavy fall. At 2 o'clock on the morning of the 7th, a certain glowing of the coal was found, and from that time on until about midnight, when the fall was completely removed, chemical extinguishers were used to control the fire.

The above description of the recovery of the fire-sealed area in the Majestic mine, shows how modern mine rescue tactics tend to eliminate the uncertainties connected with mine recovery, by substituting definite information gained from a careful reconnaissance by helmet-men.

The Two-Story Street Railway Terminal of the Public Service Railway, Hoboken, N. J.

By JOHN M. BARNEY.

The Public Service Ry. Co., operating a number of urban and interurban railway lines in the state of New Jersey, controls all of the street car lines which terminate at the Delaware, Lackawanna & Western Ry. terminal at Hoboken, N. J. At this point there are at present about 180 cars per day coming into an in-

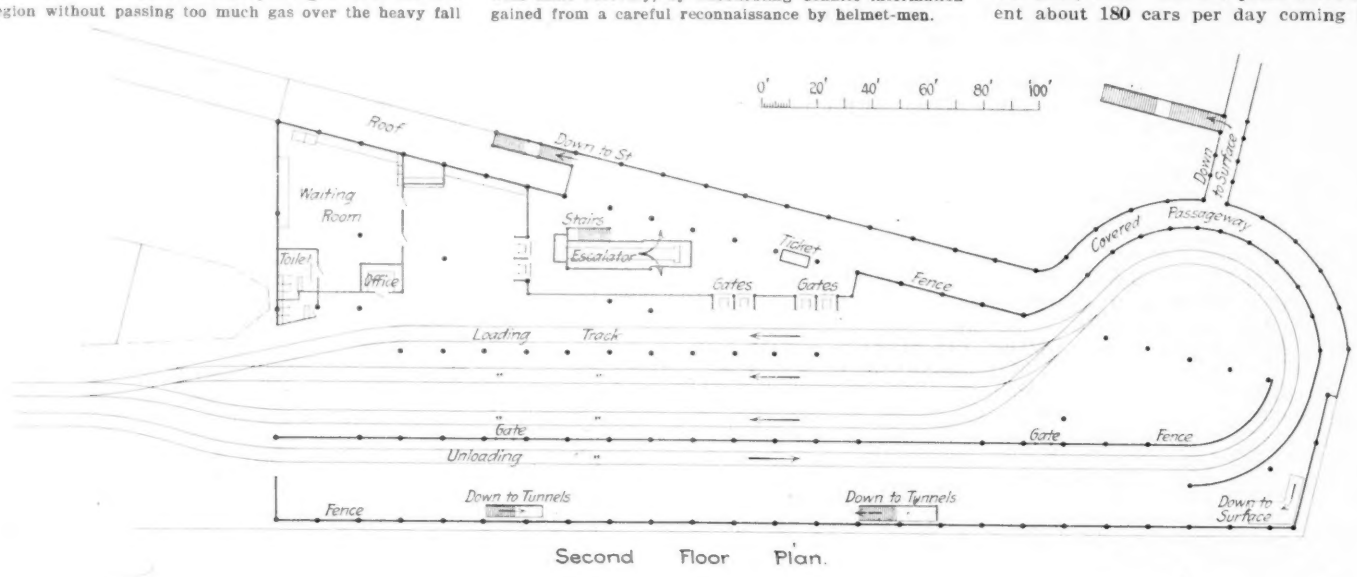


FIG. 1. GROUND AND SECOND FLOOR PLANS OF THE HOBOKEN TERMINAL OF THE PUBLIC SERVICE RY.

DUCTILE TUNGSTEN has been secured in the research laboratory of the General Electric Co., at Schenectady, N. Y., under the direction of Dr. W. R. Whitney, M. Am. Chem. Soc. It will be recalled that the great difficulty and expense in making the tungsten filaments for the new high-efficiency incandescent lamps has arisen from the extreme brittleness of the metal which has prevented direct drawing of the filaments and has made necessary the indirect squirting, or depositing, and sintering processes. While the metallurgy of the new development has not been exposed, it is stated that the improved metal has been made in a new electric furnace. When tantalum was being developed for making similar filaments, it was found that its great hardness and brittleness was caused by the presence of obscure and unsuspected oxides dissolved in the metal so that it is suspected that a similar condition has existed with the forms of tungsten heretofore used. The British firm of Siemens Brothers Works have very recently announced the sale of a lamp having a drawn tungsten filament and taking but 1 watt per c. p.

adequate loop, so that the congestion, particularly during the rush hours of the New Jersey-New York travel, has been very great. In order to relieve this congestion the railway company has now in course of construction a two-story terminal for 400 cars per day, through which all of the cars will loop. This terminal is located immediately alongside of the train yard of the Lackawanna station and directly above the Hoboken station of the Hudson & Manhattan Ry., a subway between New Jersey and New York. This latter station is in two levels below ground, the track level and a concourse level some 12 ft. higher, so that the section through the street railway terminal shows four stories (Fig. 2). This superposition of the street railway terminal on the existing subway station led to some complications of construction which are described below.

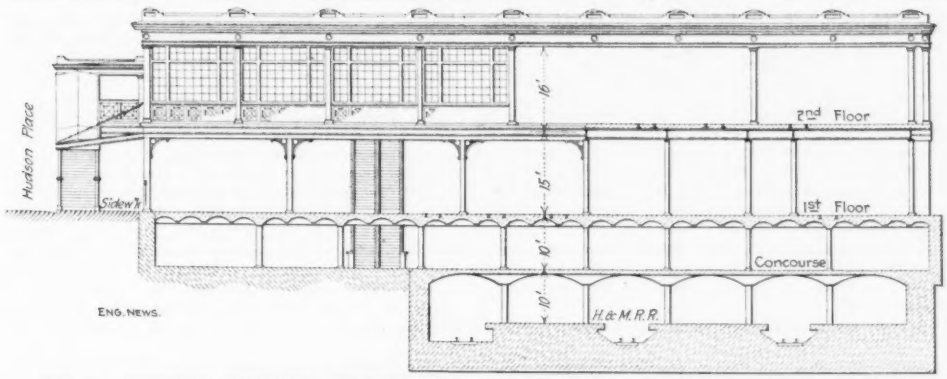


FIG. 2. SECTION THROUGH STREET RAILWAY TERMINAL STATION, HOBOKEN, N. J.

Fig. 1 shows the details of the street railway terminal. It contains two floors, into each of which the incoming cars enter on one track from which the passengers are unloaded. The car then proceeds around a loop into a ladder of tracks on the loading platform, and passes out, when loaded, without interfering with the incoming cars. On the ground floors the cars enter from the street level, but leading to the second floor an elevated structure has been built connecting with the existing elevated tracks upon which run the lines serving the district on top of the Palisades and beyond. There is also a connecting track between the two levels, as shown in Fig. 1.

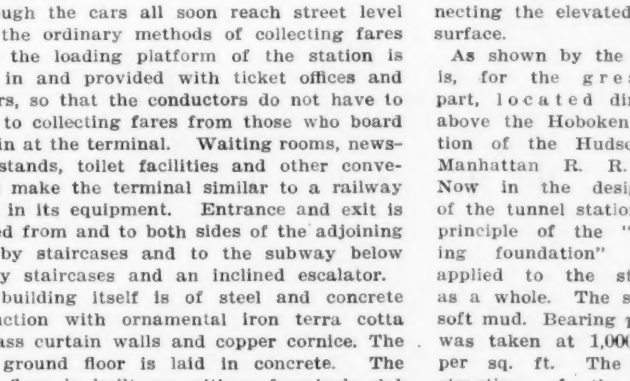
Although the cars all soon reach street level where the ordinary methods of collecting fares obtain, the loading platform of the station is fenced in and provided with ticket offices and choppers, so that the conductors do not have to attend to collecting fares from those who board the train at the terminal. Waiting rooms, newspaper stands, toilet facilities and other conveniences make the terminal similar to a railway station in its equipment. Entrance and exit is provided from and to both sides of the adjoining street by staircases and to the subway below both by staircases and an inclined escalator.

The building itself is of steel and concrete construction with ornamental iron terra cotta and glass curtain walls and copper cornice. The entire ground floor is laid in concrete. The second floor is built up with a four-inch slab of reinforced concrete, two inches of sand filler, and four inches of wood block flooring. The roof is a four-inch layer of reinforced concrete resting on nine-inch channel purlins, supported by top chords of roof trusses. Its dimensions are 397 × 373 × 145 × 53 ft., following the outline of a trapezium as to the main building. There is a triangular extension from the main building, near the northeast end across Hudson Place. This extension is at the level of the second floor and measures approximately 115 × 90 × 90 ft. There is also an elevated extension from the west end of the building to Hudson Street—a distance of some 280 ft.—carrying two tracks and connecting with the present elevated structure. There is, further, a single track emergency extension of about the same length, connecting the elevated tracks with tracks on the surface.

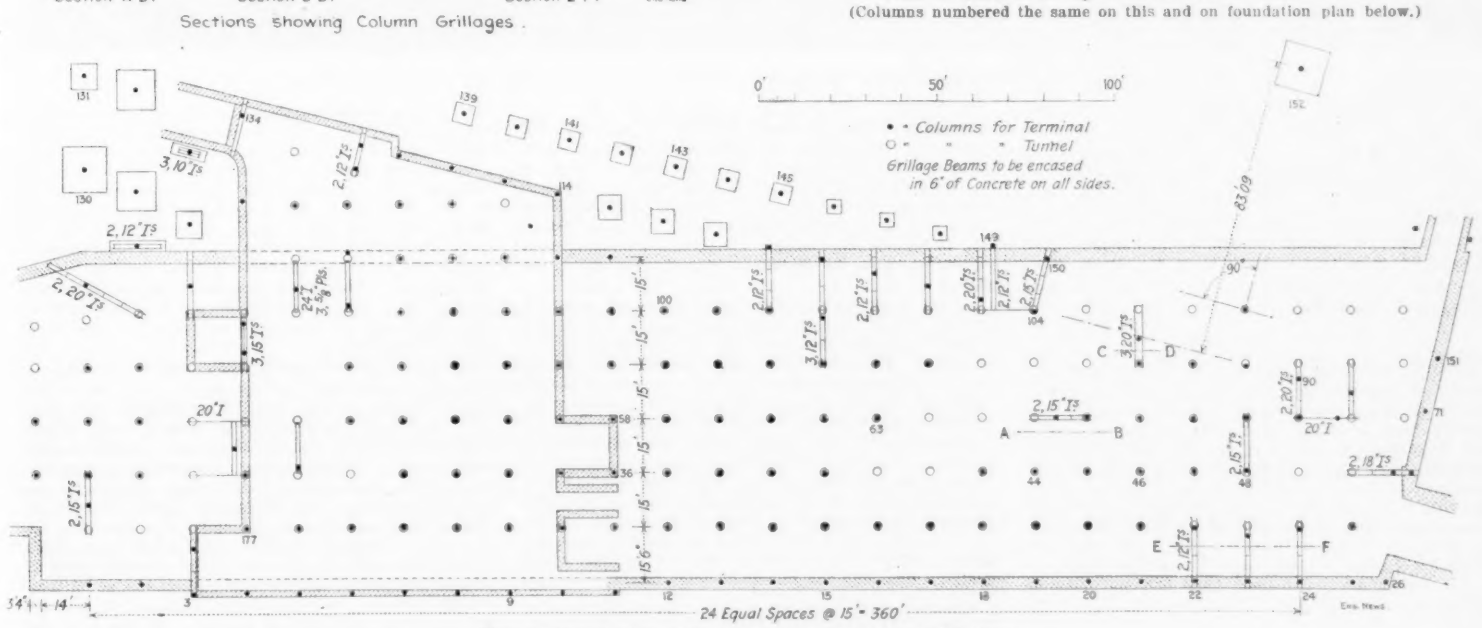
As shown by the cuts, the terminal building is, for the greater part, located directly above the Hoboken station of the Hudson & Manhattan R. R. Co. Now in the designing of the tunnel station the principle of the "floating foundation" was applied to the station as a whole. The soil is soft mud. Bearing power was taken at 1,000 lbs. per sq. ft. The construction of the roof of the tunnel does not permit of the placing of concentrated loads thereon except at column centers. On the other hand, the column spacing in the tunnels could not always be followed on account of the requirements of the trolley tracks on the ground floor of the new terminal building. A loop necessarily had to be provided at the east end of the building, another emergency loop at the west end, switches and turnouts had to be put in and car clearance looked after. Hence a considerable number of the first tier columns had to be placed over grillages to transmit their loads to the tunnel columns; and as the space between roof of tunnel and grade line was often very limited, shallow grillages of heavy section were necessary. The Bethlehem girder beams were useful in such cases. These cases of irregular distribution of column loads from above made it necessary in a number of cases to cut out the 7-in. cast-iron columns supporting the concourse ceiling, and replace them by heavier ones adequate to take the extra loading. The locations of some of these grillages is shown on Fig. 3.

Other features of interest were the two heavy trussed girders of long span over Hudson Place (Fig. 5). Owing to limitations imposed by considerations of headroom over a public thoroughfare, and by the necessity of running a passage at the level of the second floor clear across

Plan of Steel Framing of East End of Second Floor.
(Columns numbered the same on this and on foundation plan below.)



Sections Showing Column Grillages.



Plan of Foundation, showing Layout of Column Footings.

FIG. 3. DETAILS OF THE TERMINAL BUILDING, HOBOKEN.

Hudson Place to connect with a stairway leading to the sidewalk there, it was necessary to fix at 6 ft. the depth of these girders of approximately 90 ft. span. These girders are calculated to carry the dead and live loads applying to the whole floor system, the wheel loads of the trolley cars, which pass out over Hudson Place in making the loop from the incoming to the outgoing platform, and in addition the roof load of a 9-ft. covered passageway around the loop.

The moment diagram shows a maximum moment of 66,000,000 in.-lbs. They are, as will be noted, of unusually heavy section for the depth. Still, as a result of painstaking care in the treatment of the problem, they may safely be said to fulfill all ordinary requirements of a permanent structure in a public thoroughfare.

The plans for this new terminal were prepared by the Engineering Department of the Public Service Ry., Mr. Martin Schrieber, Engineer in Charge. The structural work was designed, fabricated and erected by the Fagan Iron Works of Jersey City, for whom Mr. R. G. Foster was Chief Engineer and the writer was Structural Engineer.

FIG. 4. VIEW OF HOBOKEN STREET RAILWAY TERMINAL IN COURSE OF CONSTRUCTION.

HYDRO-ELECTRIC POWER is to be developed on a large scale in connection with the Salt River Project of the U. S. Reclamation Service. About 4,000 HP. has already been developed at the Roosevelt Dam, which will be doubled as soon as three additional turbines are installed there; 5,000 additional horse-power will be developed in the valley below the dam, making a total of 13,000 HP. available. Of this amount, contracts have already been made for the sale of about 2,000 HP., giving a return of about $60,000 a year, and other contracts are pending. About 5,000 HP. will ultimately be needed for pumping, and about 1,000 HP. for irrigating the Sacaton Reservation. The pumping plants will lift water from underground wells to supply eventually about 40,000 acres of land. About 10,000 acres will be irrigated from wells during the present season.

The Chances of Pollution in Shallow Wells for Municipal Water-Supply.*

By CHARLES B. BURDICK.†

This paper presents some notes and observations bearing upon the sanitary character of water of wells used in municipal supplies, referring particularly to so-called shallow wells, or wells deriving their supply from the sands and gravels overlying bed rock. Reference will not be made to accidental sources of pollution, such as defective pipes, although this source is probably more frequent and fraught with more danger than any other. The notes deal particularly with the chances of pollution to travel through the interstices of the water-bearing materials.

It is well known that soils, particularly sands, possess the ability to purify water passing through them to a surprising degree. Ground water in its natural state, necessarily flows from the land to the nearest watercourse, and therefore where this condition of nature is undisturbed, the rainfall, in passing from its course to the stream, is subjected to a very thorough filtration. Its travel is extremely slow—usually not more than a few inches per day; close to the stream and the ground, depending upon the rapidity of the fluctuations in the stream level.

In the development of a municipal supply, a site is usually selected close to the stream, for the reason that it is at this place that the most favorable deposits generally lie. Further, at this place the ground-water level is most stable, and the elevation of the ground is usually such that the minimum depths and lifts are involved. The operating conditions largely change the state of nature close to the wells. The ground-water plane is commonly depressed considerably below the stream for some distance from the wells, varying with the character of the material, and in such situations a large part of the supply is frequently derived by infiltration from the stream. The writer has observed many situations where the supplying capacity of the inland drainage area and the sub-strata were incapable of furnishing a small part of the supply drawn from wells, and the larger part of this water must have found its source in infiltration from the river bed, although this infiltration may have occurred at a considerable distance from the well.

It is doubtless a fact, where a new well is first drilled close to a stream, that this infiltration is always most rapid where the distance of travel is least, and if this travel is greater than is desirable for filtration purposes the full beneficial effect of the filtration is not secured. It is found to be true, however, in artificial filtration that the effect of use is the clogging of the bed, and the diminution of the supply, rather than a decrease in efficiency. The tendency, therefore, is for a short path to clog most rapidly, and this, by a change in the character of the interstices, automatically reduces the rate so that it is probable that the infiltration from stream beds which reaches the well upon the bank is much more uniform over the area of the stream bottom than would be ordinarily supposed. The natural filter thus formed necessarily possesses the defect that the manner of its operations is in some doubt, and although the filtration rate is not uniform over the entire surface at any particular place, the filtration rate at any one place is possibly as uniform as that of our artificial filters. Owing to the distances traversed by such waters, the results of the process are doubtless less subject to quick change than any system of artificial filtration, and uniformity of results is an important matter in water purification.

BROOKLYN INVESTIGATION.—The Burr-Hering-Freeman commission, for its report upon the water-supply of Greater New York, conducted an experiment upon the travel of pollution at Elmont, Long Island, at a laborers camp where between 200 and 300 Italians were housed. The experiment consisted in constructing a cesspool, used by the entire camp, and noting the quality of ground water at varying distances therefrom. The cesspool was 11 × 2½ ft., and 6 ft. deep. The soil was sand, having an effective size of 0.26 mm. and a uniformity coefficient of 2.71. The original bacterial content of the soil at various depths was as follows: 615,000 per cc. at 4 ins. depth, 1,750 at 15 ins. and 800 at 27 ins., with zero at depths of 33 ins. to 72 ins. The tests for B. coli were negative at all depths.

The bottom of the cesspool was about 8 ft. above the

*Abstract of a paper presented at the annual meeting of the Illinois Water Supply Association, at the University of Illinois, March 8, 9, 1910.

†Alvord & Burdick, Hydraulic and Sanitary Engineers, Hartford Bldg., Chicago.

ground-water plane. Test wells were sunk at a distance of 10 ft. from the side of the pit, drawing water respectively 2 ft., 7 ft. and 17 ft. below the ground-water line. About a week after the cesspool was placed in use, analyses from these test wells were begun, and continued for about a month, showing that the water from all of the test wells was highly polluted. The degree of pollution apparently varied considerably (as would be expected) with the rainfall. The total bacterial count varied from 10,000 to 400,000 per cc. In 60 observations at the various depths stated, the colon bacillus was found once in 0.1 cc., six times in 1 cc. and 17 times in 10 cc. A similar experiment upon an old cesspool, whose bottom was located about 2 ft. above the ground water plane, showed similar results.

Tests were also made on wells at distances of 50 to 300 ft. All these wells beyond 50 ft. showed absence of B. coli in 1 cc. and less, and all except the wells at 130 and 160 ft. showed B. coli absent in 10 cc. The nitrates were, however, very high, and indicated that the organic matter was actively undergoing decomposition. As a result of this investigation and others, the commission concluded:

With low velocities, polluted water passing through the finer sands that exist on Long Island, for a distance of 25 ft. may be considered as practically safe for use, and it is probable that in most cases a distance less than this would serve as an efficient safeguard.

GERMAN EXPERIMENT.—A recent experiment in connection with the water-supply of Berlin has been reported in the "Gesundheit-Ingenieur." The object was to ascertain how near a well a broken sewer pipe would contaminate the supply. The experiments were made by supplying water inoculated with B. prodigiosus to the soil at a certain distance from a well at which water was drawn at a constant rate. Tests were made by delivering the inoculated water to the soil both below and above the ground water line. The water-bearing material was sand and gravel of average coarseness.

In the first experiment the well tested was 177 ft. deep, the top of the strainer 121 ft. deep, and water was drawn from the well continuously for 30 days at the rate of 380,000 gals. per day. The inoculated water was introduced 69 ft. horizontally from the well through a special well point, the inoculated water therein being kept at a constant level of from 3 to 4½ ft. above the ground-water level, requiring about 1,000 gals. of inoculated water per hour. Tests of the well water were made with extreme care, and the test bacillus was first detected in the well water nine days after the test started and at several times thereafter. As the result of the test it was concluded that 1 in 40,000 of the bacilli reached the well, and inasmuch as dangerous bacteria are more sensitive to cold water, they would be less likely to survive under the circumstances than the bacillus used in the test.

The second experiment was made upon a well 140 ft. deep, the top of the strainer being 92 ft. below the ground surface and 76 ft. below the ground-water level, which was 16 ft. below the ground surface. The inoculated water was introduced 58 ft. from the well and 4 ft. above the ground-water level. The test occupied a period of 1½ months. Water was drawn from the test well at the rate of 85,000 gals. per 24 hours. In this test no trace of bacteria was found in the well, although 8,240,000 millions of the bacillus were poured into the germ pipe.

It will perhaps be of some use to the cause of sanitation to set down some facts noted by the writer in the investigation of two public water-supplies that have recently come under his observation in the course of professional practice.

WINONA, MINN.—The situation at Winona, Minn., is interesting from a sanitary standpoint, in that for many years the municipal supply has been drawn from a system of wells immediately adjoining the business center of the city. At Winona the ancient Mississippi River excavated a channel in the native rocks three miles wide and more than 500 ft. deep, and, with the gradual recession of the water, refilled its channel to a depth of 200 ft., mostly with coarse sand and gravel.

The city occupies one of the huge sandbars left by the receding river, with the present Mississippi on its front, and a lagoon paralleling the river close to the rocky cliffs on its rear. The water-works plant is located on the river front at the end of one of the principal business streets, and immediately adjoining the business center. At the present time the city has a population of 21,000, and is consuming water at the average rate of 1,750,000 gals. per day, with a maximum day rate of 3,000,000 gals. The hourly pumpage rate during sprinkling hours frequently reaches a 7,000,000-gal. rate, no storage being provided, either elevated or otherwise.

The supply is drawn from two circular masonry wells about 50 ft. diameter, the well shoes being from 11 to 18 ft. below datum, or low water. The ground surface stands at 18 ft. above datum. The north well is about 25 ft. and the west well 175 ft. from the edge of the river. There are numerous sources of pollution, vaults, etc., within 200 ft. of the wells. A private sewer passes through the grounds about 150 ft. distant. The sewage of the city is discharged several blocks below the pumping station. The ordinary draft or depression of the ground-water level in the wells is about 5 ft., although the pumps are capable of reducing it about 15 ft. The static water level when the wells are shut down corresponds closely with the stage of the river, which ordinarily varies 10 or 15 ft. during the year. The underlying material is principally coarse sand to a depth of 175 ft. below the ground surface, having an effective size of from 0.35 to 0.45 m.m., and a uniformity coefficient of about 3.5. The supply under the well shoes is supplemented to a slight extent by numerous drive-well points in the bottoms of the open wells to a total depth of 60 or 70 ft. below the ground surface. The supply from these points is said to be inconsiderable owing to the corroded condition of the strainers. A small amount of water leaches through the masonry of the wells, but the major portion of it comes under the well shoes. In regard to the character of this water, the Minnesota State Board of Health concluded:

No wells could be recommended which receive surface water in relatively thickly-settled portions of the town, and situated as close to a badly polluted water as that of the Mississippi River water at Winona. . . . These dug wells cannot be endorsed by any sanitary authority, not that they have constituted a source of danger as evidenced by typhoid and digestive disturbances, but that they may, if excreta from patients should find its way into the wells.

The total bacterial count in the water is extremely low, running from 3 to 50 per c.c. It is noteworthy, however, that B. coli were found present in four out of ten observations in 1 c.c. Upon the whole, however, it is surprising that water as favorable in character is obtained under circumstances apparently so detrimental to the sanitary supply. The typhoid death rate per 100,000 in 15 years has never exceeded 40, has exceeded 30 only twice, has exceeded 20 eight times, and has been less than 10, eight times, or over 50% of the time.

MANISTEE, MICH.—The situation is in many respects similar to that of Winona. The water-supply is derived from the sands and gravels of the ancient Manistee River terrace. The ancient river cut through a bank of clay to a depth of about 200 ft., and a width of about 1½ miles, afterwards refilling its channel with the sands

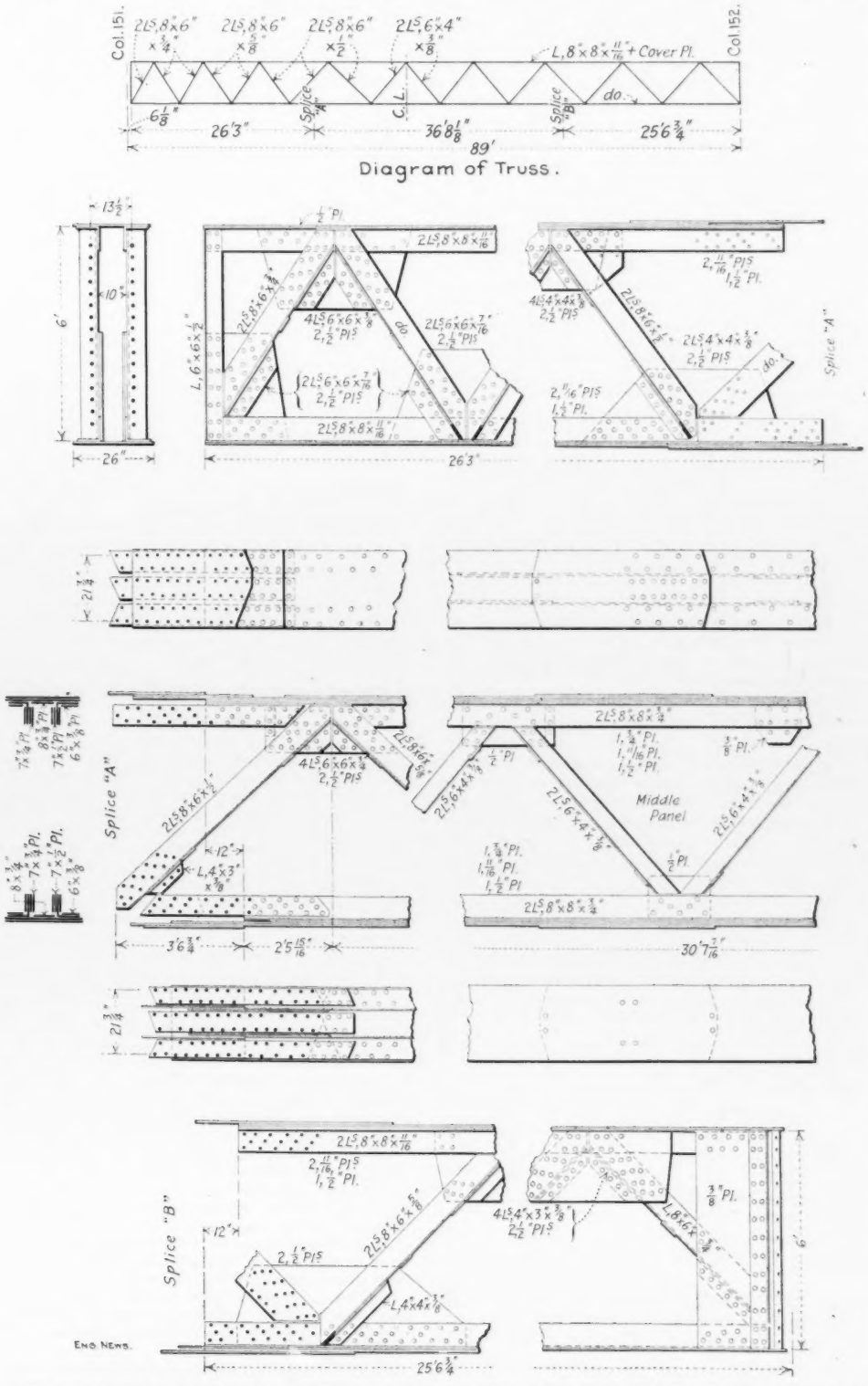


FIG. 5. DETAILS OF HEAVY TRUSSES CARRYING PORTION OF HOBOKEN STREET RAILWAY TERMINAL ACROSS HUDSON PLACE.

and gravels from which the present supply is derived. This material below the ground-water plane is fairly homogeneous. The sand has an effective size of about 0.35 m.m., and a uniformity coefficient of from 2 to 2.5.

As at Winona, the water-works plant closely adjoins the inhabited part of the city; in fact, occupies the ground that was first settled. The business part of the city, however, is at some distance from the plant. There are a number of vaults at present in use, 250 to 500 ft. distant from the wells forming the source of supply. A 9-in. pipe sewer at a depth of 10 ft. passes within 20 ft. of well No. 3, and a similar sewer 6 ft. deep within 37 ft. of well No. 4.

The site of the water-works is 25 ft. above river and lake level. The ground-water plane in a state of rest is about 2 ft. above the same plane of reference, and, when the wells are pumped, is drawn down at the rate of about 1 ft. for each 250,000 gals. of pumpage.

The present population is about 14,000. The average daily consumption for the past year has been 951,000 gals. The maximum 24-hour consumption is 1,500,000 gals. and the maximum rate during the sprinkling hours of a hot summer day, between 6 and 8 p. m., is from 3,000,000 to 4,000,000 gals.

The supply is derived from four masonry-curbed wells, from 30 to 45 ft. diameter, and 34 to 44 ft. in depth below the ground surface. The supply is largely supplemented by three 8-in. pipe wells, driven one each in the bottom of the three principal open wells. These pipe wells penetrate an additional depth of 60 ft., and are packed in an ingenious manner with gravel. They have no strainers, the water being admitted through perforations in the pipes. The supply is therefore drawn at two places: (1) Under the well shoes from 8 to 20 ft. below the ground-water plane, and (2) from the pipe wells 40 to 60 ft. deeper.

The total bacterial count was usually less than 50, but it varied from day to day, occasionally exceeding 500 cc. In about 140 observations the presumptive test for the B. coli was negative in all tests on 0.1 cc.; in 1 cc. it was positive once, and in 10 cc 13 times. In a 10-year record the typhoid death rate has exceeded 40 (per 100,000) once, 30 once, 20 three times, 10 six times, and has been less than 10 four times, or 40% of the time. The average death rate is less than 15.

In the light of all these data, it cannot be successfully maintained that the character of the water-supply has had a detrimental effect in the matter of local typhoid. In view, however, of the environment of the wells, the possibilities for contamination, and the occasional evidences of sewage pollution during the period of the examination, it was concluded that the water was not safe for continued use without treatment.

DISCUSSION OF DATA.—The writer must confess some surprise that the continued public use of water from such sources as these has apparently done so little harm, and the explanation is doubtless to be found in the fact that the bacilli of disease are apparently eliminated by processes less effective upon other forms of bacterial life, sufficiently easy of recognition to be useful in practical water examinations.

There is an important work for our university experiment stations in the study of this subject, and in the endeavor to formulate methods of investigation more certain than we have at present in the separation of the bad from the good. The sanitary determinations often govern considerable expenditures, and while the wise analyst will always condemn in case of doubt, it is very important that the realm of doubt be confined to limits as narrow as possible, for to unjustly condemn tends to the detriment of sanitation generally.

A PRIVATE WATER-WORKS PLANT is proposed by the packing-house and stockyards interests in Chicago, and an ordinance authorizing the construction of such a plant has been introduced in the city council. The Stockyards Water Co. has been organized to undertake the work. The plans provide for an intake tunnel extending about three miles under the lake, and connecting with a 7-ft. conduit. It is intended to furnish about 75,000,000 gals. daily. The cost is estimated at $1,500,000, and the works could be built in about two years. As the ordinance presented asks for a 30-year franchise without any compensation to the city, and as the plant would materially reduce the city's revenue from its own water-supply station there is considerable opposition to the granting of the ordinance.

Statistics of Water Supply in French Speaking Cities of Over 5,000 Population.

The recently-issued manual of water-works of French speaking cities, "Annuaire Statistique et Descriptif des Distributions d'Eau de France, etc.," contains an introductory chapter in which are summarized water-works statistics of all of the French speaking cities of Europe with a population of over 5,000, for Jan. 1, 1909. There is much interesting and valuable information in this summary, particularly in giving some idea of the sanitary status of these countries. In the review of the first edition of the manual, published in Engineering News (Engineering Literature Supplement, Jan. 14, 1904, p. 5), Mr. Allen Hazen abstracted the figures given then, for Jan. 1, 1903, and a comparison of the earlier figures with those here presented will serve to show the progress in the past six years.

Table I. gives some interesting water-works statistics for cities over 5,000 in France, Belgium, Switzerland and Luxembourg, at the end of 1908. Table II. is a less complete presentation for Jan., 1903. From these tables it will be seen that those

TABLE II.—SHOWING WATER-WORKS OF CONTINENTAL FRENCH-SPEAKING CITIES OVER 5,000 POPULATION.

(Brought to Jan., 1903.)

	No. of cities	No water supply	Public Fountain only	Full water supply	Percentage of total %
France	616	148	34	434	71
Belgium	220	148	5	78	36
Switzerland ...	36	..	..	36	100
Luxembourg...	7	..	..	7	100

continental cities are far behind American cities of a similar size in the matter of water supplies and that the increase in water-works has no more than kept pace with the normal increase in population. Other points to notice are the high proportion of publicly-owned works and the low per capita consumption.

The predominance of municipal ownership in 1909 in all four of the countries listed in Table I, is notable.

The sources of the water-supply are not so easily tabulated, because a number of cities draw their water from two or more sources, particularly those cities where there is a double water-supply; that is, one for street cleaning, washing, manufacturing, etc., and another, of purer quality, for drinking. However, the figures given in Table III, are nearly correct for France and Belgium.

TABLE III.—SOURCES OF WATER-SUPPLY OF FRENCH AND BELGIAN CITIES OVER 5,000.

(As on Jan. 1, 1909)

	French Cities.
Springs	*255
Surface waters	37
Deep wells	65
Deep collecting galleries	12
Galleries near rivers	57
Reservoirs	16
Lakes	8
Rivers	†145

	Belgian Cities.
Springs	41
Surface waters	5
Wells	15
Deep collecting galleries	31
Galleries near rivers	2
Reservoirs	3
River (filtered)	2
Canal (filtered)	1
River (raw)	4

*Two treated by ozone process and three by sand filters.

†Seventy-three of these, 46 of which are in a group around Paris, have filtration systems; 2 have ozone purification. 36 are in double system and 34 draw the river water raw.

TABLE I.—SHOWING THE WATER-WORKS STATUS OF CONTINENTAL FRENCH-SPEAKING CITIES HAVING OVER 5,000 POPULATION.

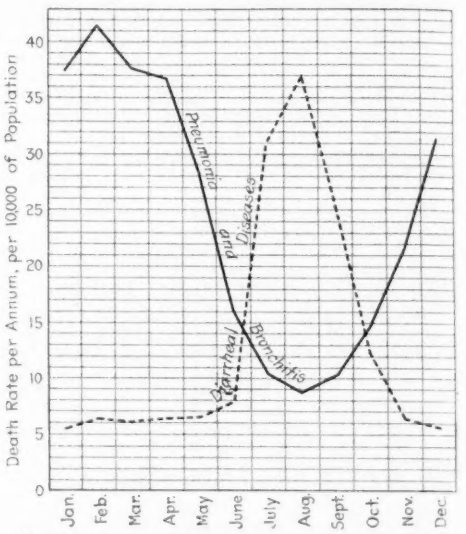
(Brought Down to Jan. 1, 1909.)

		No present water supply		Full water supply		Distribution.		Ownership.		Power.		Rates.	Costs.		Consumption
		None	Supply		Percentage	Public Fountains alone	House connections	Public.	Private	Gravity	Other	1,000 gals.	Original	Original per 1,000 gal. per day.	per cap. per day, gals.
Country.	No. of cities.	No. in prospect	No. in prospect	No. of cities.	of total.	No.	No.	No.	No.	No.	No.	per day.	per head.		
France	643	117	22	504	79	25	479	317	162	195	309	$0.020	$16	$328	50
Belgium ...	261	128	38	95	36	1	94	69	26	41	54	....	9	320	24
Switzerland.	43	..	..	43	100	..	43	39	4	30	13	0.015	14	....	..
Luxembourg	7	..	..	7	100	..	7	7	..	4	3	....	5	140	40

Note—26 of the cities recorded in Switzerland are German-speaking and 17 are French-speaking.

Monthly Curves of Impure-Air and Impure Food Diseases, Chicago.

We reproduce herewith a striking diagram from the weekly Bulletin of the Chicago Department of Health of March 19, 1910. It needs no



Monthly Curves of Impure-Air and Impure-Food Diseases, Chicago.

further comment than the two paragraphs which accompany it in the Bulletin, and which we reprint as follows:

IMPURE-AIR DISEASES, Pneumonia and Bronchitis.—*High* in winter when people house themselves up and breathe the foul air of unventilated rooms. *Low* in summer when people keep their doors and windows open, when people live more in the open air.

IMPURE-FOOD DISEASES, Diarrheal Diseases.—*High* in hot weather chiefly because of dirty milk for babies' food and contamination of foodstuffs by flies, dust, etc.

Tests of Locomotive Headlights in Relation to Signals.*

By C. H. BENJAMIN.†

The recent discussion in railway circles regarding the desirability or undesirability of more powerful headlights than the oil lamps now in general use, leads me to give a brief account of some experiments made under my direction during October and November, 1909, at the request of Judge Wood, Chairman of the Railroad Commission of Indiana. A full report of them has been published by the Commission.‡

It was proposed originally to include oil, acetylene and electric lights in the experiments, but lack of time necessitated omitting the acetylene light. The object of the tests was to determine the relative effect of oil and electric headlights upon the reading of signal lights and the identification of obstacles, and by suitable laboratory experiments to determine the causes of the differences which might be found to exist. In order to arrange a program which would be satisfactory to all parties concerned, I called into consultation, Mr. Houghton, of the New York Central Lines, Mr. Crawford, of the Pennsylvania Lines, Prof. Harding, of the School of Electrical Engineering at the University, and Prof. Endsley, of the Department of Railway Engineering.

The observers (11 in number) did not know the actual aspect of the signal or the nature of any obstruction. The general method adopted in all of the tests was to run the observation car back several thousand feet from the home station, when the signal was given by whistle to those manipulating the lights, obstructions, etc. The car was then run slowly forward towards the station, stopping at regular intervals for observations. The distances from the home signal were determined by numbered stakes previously located. Each observer was instructed to make his record without consultation with others.

The first series of tests included experiments in reading the home signal at various distances under three sets of conditions: (1) With opposing electric headlight; (2) with opposing oil headlight; (3) with no opposing

*Abstract of a paper presented at the April meeting of the Western Railway Club, Chicago. A paper on the same subject was published in our issue of Dec. 30, 1909.

†Dean of the School of Engineering, Purdue University, Lafayette, Ind.

[‡An account of the efforts to enforce the use of high-power headlights in Indiana, leading up to the Railroad Commission's tests was printed in Engineering News, June 10, 1909. An order requiring 1,500-c. p. headlights was noted in Engineering News, Jan. 13, 1910. At that time it was announced that the Commission's enquiries showed such headlights distinctly advantageous—a finding quite adverse to Prof. Benjamin's notes given here.—Ed.]

headlight. This series was carried out with an electric headlight on the observation car and repeated with an oil headlight on the car. When an opposing headlight was used, it was located on the adjacent track and 200 ft. in front of the home signal.

A brief study of the figures shows the disconcerting effect of an opposing electric headlight, as there was no general recognition of the signal until the observers were within 1,500 ft., and practical unanimity was secured at 800 ft. With an opposing oil headlight, a similar unanimity existed at 3,000 ft., or nearly four times as far. Where there was no opposing headlight, the signal was recognized at 4,000 or 5,000 ft. without much difficulty.

The tests were repeated using an oil headlight on the observation car, and as far as the relative effects of the opposing headlights are concerned, the conclusions are the same as before. With electric headlight opposing, there was no unanimity in the reading of the signals until the observers were within 1,000 ft. With oil headlight opposing, and with no headlight opposing, there was nearly unanimous recognition at 4,000 to 5,000 ft.

In comparing this second series with that first mentioned, one important difference is noticeable. In the first series there are numerous instances of green lights being seen by observers at distances of 800 ft. and under, where no green light should have been visible. These phantom lights must have been due in most cases to light reflected from the lens of an unlighted lamp behind a green roundel, passing through the roundel and thus becoming green. A direct reflection from a roundel will be white or yellowish and not affected by the color of the roundel. This has been proved by experiment.

In one case, the upper right-hand signal had a green roundel with an unlighted lamp behind it. At 600 ft., eight observers saw a green light in this signal and at 400 ft. seven were thus deceived. Other records show similar false lights. The reason for the reflections being visible at this particular distance is due to the angle of reflection being right for the observer at this point. We thus have numerous examples of a signal whose light which was out showing at "safety."

This effect was not noticeable when the car was equipped with an oil headlight, probably because the light was not powerful enough to cause reflections visible at this distance.

Tests were made also on train-classification signals. The observation car was retired to a distance as before; another engine with opposing headlight was then run on the same track near the home signal. This engine displayed classification signals unknown to the observers. The car moved slowly towards the engine and observations were made at 400, 300 and 200 ft. A study of the results shows that when an approaching engine has an electric headlight, the green signal is invisible at 200 ft. and over, while a white signal can be seen at 800 ft. or more. The opposing oil headlight obscures the classification signals but little; both white and green signals were read correctly by all at 600 to 800 ft., while some observers saw them at double this distance.

The effect of an electric headlight on the car was to diminish the distance at which the classification signals became distinctly visible. This is particularly noticeable when there is any rain or fog present; the electric light produces a wavering ghostly sort of radiance which at times is confusing. During the tests the sky was overcast and there was a slight rain in the early part of the night.

Some weeks later, Prof. Endsley and myself rode on an engine from Indianapolis to Terre Haute and return. The engine on the westward trip was equipped with an electric headlight, while on the return an engine with an oil headlight was used. Nothing particularly new was learned on this trip, but the observations confirmed the conclusions previously formed. Phantom lights both white and green appeared at intervals on home and distant signals during the outward trip. At one station where the lights were all out, comparatively brilliant white lights were seen first in the distant signal and later in some of the lamps of the home signal.

With the electric headlight, conspicuous objects such as crossing guards or highway bridges could only be seen at distances less than 1,200 or 1,500 ft. The home signals could be seen at about 1,500 ft. with the electric light, but could be seen further when the oil light was used. The presence of an opposing electric headlight obscured all signals, both block and classification. This seemed to us to constitute the strongest objection to the use of such a light.

Subsequent experiments on the electric and oil lights used in the road tests were made at Purdue University. These will form an important part of the evidence contained in the report to the Railroad Commission. The laboratory experiments showed the electric light used to be very weak in the red rays and strong in the green rays. This in part explains the prevalence of green reflections in dead signals and the greater obscuration of green classification signals.

Out-of-door tests showed reflections from red and green roundels and that these were much more brilliant when the roundel was in front of an unlighted signal lamp. Due to the greenish character of the electric light, it was easy to get green reflections while no red was observed in the reflection from a red roundel.

The signal experiments were followed by some tests to determine the limits of the visibility of various obstructions on the track. For each test, the observation car was run back some 2,000 ft. and on signal some obstruction was arranged. Neither the nature nor the precise location of any obstruction was known to the observers. As the car was run slowly forward, each one tried to locate and describe the obstacle. Only the electric headlight was used in these experiments.

A speeder or tricycle on track was noticed at a distance of about 700 ft., but was not fully identified until the distance was 300 ft. Coal cars were first noticed by the majority of the observers at 1,300 ft., but were not identified until the distance was reduced to about 1,000 ft. That a car on siding was not in the clear was not noticed by the majority, even some of the railway men failing in this regard. Dummies on the track were hardly noticeable at distances of over 200 ft.

The following conclusions are taken from my report to the Railroad Commission:

(A) An electric headlight on the engine of a train has one marked disadvantage, namely, the causing of reflections from glass roundels and lenses, thereby producing false or phantom signals. This is not due entirely to any peculiarity of the electric light but to its great power and intensity as compared with ordinary signal lamps.

(B) Obstructions on the track cannot ordinarily be seen with an electric headlight at a sufficient distance to prevent the probability of accident.

(C) An opposing headlight adjacent to block signals so obscures them as to make it difficult to read them correctly at distances exceeding 1,000 ft.

(D) An opposing oil headlight allows such signals to be read correctly at distances of 4,000 ft. or less.

(E) The electric headlight on an approaching engine obscures the classification signals on that engine to a marked degree; this is noticeably true of green signals, as these are almost entirely obliterated by the glare of the electric light.

(F) An opposing oil headlight allows either white or green signals to be read at a distance of 400 ft. or even more.

I feel justified at the present time in stating my personal opinion in this matter, with the understanding that it is only my opinion and does not in any way commit my associates.

All of the tests tend to convince me that it is a disadvantage to the engineman and fireman of a train to have an electric headlight on their engine, since it interferes with the correct reading of signal lights; and that it is still more a disadvantage to the crew of an engine to have electric headlights on engines which they meet on parallel tracks and at stations. Furthermore, I do not consider that the greater illumination of the track ahead, or of objects on the track is any compensation for the disadvantages just mentioned.

If it be admitted that the engineman's responsibility is chiefly to his train and to the passengers dependent on his skill and faithfulness, it is evident that whatever interferes with his correct reading of signals on track or engine, is to be condemned, however much it may help to warn chance pedestrians of the approach of danger.

Sewerage and Sewage Disposal Statistics for Cities in France and Germany.

M. Ed. Imbeaux, one of the editors of the recently issued second edition of the French waterworks manual, "Annuaire des Distributions d'Eau*," has availed himself of material collected in the preparation of that book to compare the sanitary condition of the cities having a population exceeding 5,000 in France and Germany, respectively. The data on the French cities have not been tabulated, but the German water-works manual, "Die Stadtische Abwasserbeseitigung in Deutschland," has most complete tabulations of the statistics for the German cities, and these have been abstracted in M. Imbeaux's paper, which we have in turn abstracted in part. The figures are brought to 1909 for the French cities and to 1907 for the German.

*Reviewed in Engineering News, Engineering Literature Supplement, Jan. 13, 1909.

FRANCE.—Of the 643 cities of more than 5,000 inhabitants, 320, or 50%, have no sewers whatever, 257, or 40%, have storm sewers alone, and 66, or 10%, have complete storm water and house sewers. In the second class of cities, those having storm water sewers alone, the sewers are in nearly every instance very old and insufficient, both in size and condition, for the work they are called on to do. Even in those cities which are properly placed in the third class, that is, completely sewered, there are still a number of privies of one sort or another. Of these 66 cities, 4 only have a separate system, the remaining 62 have installed the combined system. Of the cities not now completely served with sewers 3 are now installing separate systems and 9 others have projects under advisement.

In the matter of sewage disposal, two cities only, Paris and Rheims, have adopted broad irrigation on a large scale; 27 others irrigate surrounding fields to some extent; 5 others have biological purification plants, 4 cities empty into the sea and the remainder into nearby rivers.

GERMANY.—The sanitary status of the German cities is best shown by the accompanying table. It will be seen that of the 719 cities over 5,000 population, 193, or about 27%, have good sewerage systems; 63, or 9%, have partial systems; 151, or 21%, have storm water sewers; 138, or 19%, have more or less completed systems in project; and 174, or 25%, have no system of any kind either at present or in prospect. The kinds of systems and methods of purification are given in the remainder of the table. This shows that the German cities are in advance of their French neighbors as far as the sewering of the cities is concerned, but this is a very recent development, for in 116 out of the 256 German cities now having sewerage the improvements have been made since 1900.

TABLE SHOWING SEWERAGE STATISTICS OF CITIES OVER 5,000 IN GERMANY.

		Alsace-Lorraine.	Baden.	Bavaria.	Prussia.	Saxony.	Wurtemberg.	Other states.	Total in Germany.
	Cities with population over 5,000..	27	19	57	442	63	30	81	719
	With complete sewer systems.....	3	4	9	146	8	1	22	193
	With partial sewer systems.....	6	1	7	35	6	1	7	63
	With storm water systems only...	9	12	17	60	14	21	18	151
	With systems in prospect.....	6	2	9	112	1	4	4	138
	With no systems in prospect.....	3	..	15	89	34	3	30	174
Kinds of systems in the 256 sewered cities.	Combined system	9	5	14	95	14	2	23	162
	Separate system	..	..	..	57	..	..	2	59
	Partly separate and combined.....	..	..	2	29	..	..	4	35
Methods of purification in the 256 cities having sewerage systems.....	Irrigation*	..	1	..	41	..	..	5	47
	Intermittent filtration	..	1	1	2	..	..	..	4
	Biological purification	1	..	1	32	1	..	3	38
	Mechanical-chemical purification..	..	..	..	6	1	..	1	8
	Mechanical separation†	1	2	1	75	2	..	9	90
	House purification systems.....	..	..	..	2	1	2	2	7
	No purification	7	1	13	23	9	..	9	62

*Of these 47 cities, 6 do not utilize the ground irrigated.
†Of these 90 cities, 11 have only screens as mechanical separators.

Notes from Engineering Schools.

STEVENS INSTITUTE OF TECHNOLOGY.—The trustees of this school are endeavoring to recover with interest $45,750, which was paid to the government in 1870 as an income tax on a bequest of Mr. E. A. Stevens amounting to $650,000. The claim for reimbursement, now urged upon Congress, is based on the remission of similar taxes on Vassar College, and on various church and school properties in Massachusetts.

UNIVERSITY OF WASHINGTON.—The U. S. coal mine rescue station No. 4, was formally opened at the school of mines, March 12. The rescue station is installed in what was the Philippine Building of the recent Seattle exposition, which has reverted to the university. The equipment, costing about $2,000, was installed at the expense of the mine operators of the state. The building measures 50 × 140 ft. and, in addition to the 22 × 50-ft. smoke room, contains an office, library, workshop and audi-

torium. Men will be sent from the various mines to learn the use of the oxygen helmet for mine rescue work. The course of instruction will require ten days and will be supplemented by special instruction in the school of mines on ventilation, origin and composition of mine gases, characteristics and uses of Pacific Coast coals and the geology of the Puget Sound coal fields.

UNIVERSITY OF WISCONSIN.—The remodeling of the old university heating plant into the mining engineering building is now nearly complete and the machinery is being installed. A concrete floor has been put in to divide the building into a basement and an upper story. An open mill space will be left in the south end and an extension has been fitted for the metallurgical furnaces. The basement is to contain the crushing and screening room, ore bins, supply room, dark room, and ash wells. The upper floor is divided into a large assay-furnace room, a chemical laboratory, a balance room, two offices, and the gallery on which will be installed the hand ore-dressing equipment and the mining museum. All dust-producing operations, so far as possible, will be confined to the crushing room, where an exhaust ventilating system will keep the air free of the flying particles from the ores. Both jaw and gyratory types of crushers and the screens and trommels for the dry screening (which will be done by hand) are to be in the crushing room, where there are also to be disk and ball grinders and rollers. Magnetic concentrators and separators are also to be set up in the crushing room. The fire-assay equipment consists of eight large double-muffle coal furnaces and one triple-muffle coal furnace, eleven crucible coke furnaces and a collection representing the different types of gasoline and gas assay furnaces. In the metallurgical extension there is to be a small reverberatory and a small shaft furnace, with space for further expansion. At the southern end of the building the wet-concentration equipment is being placed. This apparatus will include jigs, of the Hartz, moveable-sieve, pulsator and special laboratory types, classifiers, settling cones, a Frue vanner and a Wilfley table. Each student will have a separate laboratory desk supplied with air and gas and will have a separate pulp balance. A precise gold balance will be provided for each group of three students. Lockers and a shower bath will be installed for the students.

SEPTIC TANKS for treating the sewage of Florida cities have been established to date at Gainesville, Lake City, New Springfield (suburb of Jacksonville; by a development company), and Tallahassee, and bonds for the purpose have been voted at Bartow. No further means of treatment has been adopted by the cities named. For the foregoing information we are indebted to Dr. Hiram Byrd, Assistant Health Officer of the State of Florida, Jacksonville, Fla.

THE COLUMBIA RIVER BRIDGE on the North Coast Ry., in Washington, has had work on the piers discontinued temporarily on account of very unusually high water early in the season. It is not expected that work on the piers can be resumed until after the period of the annual flood waters, or about the latter part of July. The permanent substructure will consist of 12 piers, and the superstructure will comprise nine Howe truss spans and a draw span. Six of the piers have been finished, two have reached the water line, and one has not been commenced. There will be trestle approaches on each side of the river. Mr. F. L. Pitman is Chief Engineer.

A LOCOMOTIVE BOILER EXPLODED April 16 in the Monterey yards of the National Rys. of Mexico. Eleven men were killed and two others injured.

A PASSENGER TRAIN WAS DERAILED April 18 on the Illinois Central R. R., near Jackson, Miss. The locomotive first left the rails and carried with it the baggage, mail and library cars and two sleeping cars down a 15-ft. embankment. Four mail clerks were killed and four other persons, none of whom was a passenger, were injured. The bodies of the dead clerks were consumed by a fire which started in the wreckage.

AN OLD BOILER EXPLODED April 14, at 7.30 p. m., at the plant of the Robinson (Ill.) Water, Light & Heat Co. The boiler, of the horizontal fire-tube type, was one of three in the power-house. Photographs of the wreck sent in by Mr. J. P. Lyon, a civil engineer of Robinson, show that one sheet of the cylindrical shell, the sheet nearest the front end of the boiler, was torn apart on the bottom side with a remarkably straight longitudinal tear. The rivets of the two girth seams joining the torn sheet to the adjacent sheet and front tube sheet, respectively, were either sheared or pulled apart for more than half of the boiler's circumference. Some of the lower tubes were somewhat bent, but none were pulled out entirely from the tube sheet. The reaction threw the boiler up and backward and a little to the right so that it landed bottom up on top of the other boilers. The power-house was completely wrecked, only the chimney and portions of the brick walls being left standing.

THE ATLANTIC TRANSPORT LINER "MINNEhaha" on April 18, at 2 a. m., went aground on the rocks at the western end of the Scilly Islands just west of Lands End at the southwestern end of England. Immediately after striking, boats were lowered and signals and wireless messages sent to the nearby Bryher Island from which fishing boats soon put out to pilot the ship's boats, filled with passengers, to shore. All of the 68 passengers were thus landed safely before morning, and most of the cattle, which formed the larger part of the ship's cargo, were landed safely the next day. The ship is still fast on the rocks and at last reports it is about an even chance that it can be saved. All solid cargo which was in the forward hold where the ship struck has been jettisoned so as to lighten the ship, and as the engine rooms have not filled with water, it is hoped that salvage will be possible.

The "Minnehaha" is in command of Commodore Leyland, the veteran of the Line, and one of the most careful and trustworthy of the transatlantic captains. His boat had been in a heavy fog for four days previous to the grounding and he had been proceeding on dead reckoning.

AERONAUTICAL ACCIDENTS.—Many accidents to balloons and aeroplanes have been reported this week. The balloon "Delitzsch" of the Parseval company, which ascended at Bitterfield, Prussian Saxony, on the evening of April 16, with a crew of four, was swept into a hurricane and wrecked near Reichensachsen, 20 miles from Eisenach and about 100 miles southwest of the starting point. The entire crew was killed. Instruments recovered from the wreckage are reported to show that the fall was from a height of 8,445 ft.

During an ascent of a military dirigible balloon at Berlin, Germany, April 14, in the presence of some 300 of the Prussian Parliament, the aeronaut became entangled in the guide rope and was carried aloft only to be dropped, receiving probably fatal injuries. On the same day Major Parseval's new aeroplane, said to be the largest yet built, was wrecked in a heavy wind while flying over Lake Plau. The two mechanicians escaped uninjured. It is reported that this monoplane was 45.5 ft. in breadth and 45 ft. long and was equipped with a 120-HP. motor with tanks for a three-hours' supply of gasoline.

On April 15, a storm struck the aviation field at Chalons, France, killing three workmen, injuring three, and destroying the Farman workshops with nine aeroplanes in them. Many aeroplane and dirigible-balloon sheds on the field were demolished.

An aeronaut, one Rougier, fell into the sea while flying near Nice, France, but was rescued. The failure of his machine is attributed to a defective rudder. Another aviator, Louis Brégnet, received severe injuries as a result of a 60-ft. fall from his capsized aeroplane while performing near Douai, France. It is reported that the trouble was caused by a broken propeller.

A CROSS-COUNTRY AEROPLANE TRIP of 220 miles was recently made, in three stages, from Etamps, about 30 miles south of Paris, France, to Chalons-sur-Marne, with a Farman machine. The first stage of 50 miles, Etampes to Chevilly, was made by Henry Farman and the two other stages, Chevilly-Arcis and Arcis-Chalons, 130 and 40 miles, respectively, were made by Louis Paulhan in the same machine. The trip was completed April 19 and the actual time of flight for the whole trip was five hours.

A FIRE AT THE NEW HAVEN COUNTY JAIL April 13 destroyed two three-story brick workshops and several adjoining sheds. Ten firemen, while fighting their way from the cell building into one of the workshops, were imprisoned in the shop by the accidental closing of the iron doors between the two buildings and six of them were killed. The doors were slammed shut by the draft caused by the explosion of a gasoline tank. The men were unable to force an exit from the burning shop. Three are reported to have saved their lives by clinging to the bars of a window with a stream of water playing on them from outside. They were rescued from this position after the roof fell in. The other one of the four who escaped alive succeeded in reaching the roof and dropped from there to the ground.

THE POWER-HOUSE OF THE KITTANNING ELECtric Light Co. and the Kittanning & Leechburg Street Ry. Co., near Kittanning, Pa., was destroyed by fire April 14. New machinery, installed within the past two months and not yet put into use, which was valued at $117,000, was damaged beyond repair. The fire is reported to have resulted from an explosion in the oil filter. The power-house supplied current for the street railway line between Kittanning and Ford City and the Kittanning street lighting circuit.

THREE PREMATURE DYNAMITE BLASTS last week killed a total of 20 men. The first of the three was on April 13 in the stone quarry of the Nazareth Portland Cement Co., Nazareth, Pa. Four holes, each 24 ft. deep had just been loaded and were discharged in some unexplained way before the men had reached a safe distance. Seven men were killed and three others were injured.

In a rock cut on Section 2 of the Lackawanna cut-off April 14, five men were killed and four others injured by a premature blast near Netcong, N. J. Press reports state that a combination of dynamite and black powder was being used.

A blast on the line of the Ha Ha Bay Ry. near St. Alphonse, Que., April 14, caused a landslide which buried the construction camp under tons of earth and rock. Twenty men in a shanty in the camp were buried. Eight of these men, including Stanislas Gagne, Assoc. M. Can. Soc. C. E., are reported to have been killed. Mr. Gagne was Chief Engineer in charge of the construction work. Several men in the gang at work at the top of the hill were carried down on the landslide and severely injured.

THE WARPING OF SHEET-ANNEALING BOXES or covers can be minimized or prevented, according to a note of W. Krämer in "Stahl and Eisen" of March 23, 1910, by making the horizontal reinforcing ribs continuous around the corners and with heavier section at the corners than at the middle of the sides. Vertical ribbing is to be omitted, as it tends to crowd in the edges of the opening. With these two modifications, he claims, a box showed little warping after 60 heats, while another box not so constructed after only 18 heats warped sufficiently to need repairs. Both boxes of course were steel castings, in accordance with general practice.

OPERATING STATISTICS OF THE ST. CLAIR TUNnel under steam and electric traction are given brief mention in a long article in the "Electric Railway Journal" of April 2. This electric system was described in Engineering News Nov. 19, 1908, and a few operating data were given in our issue of March 18, 1909. In the recent article above noted, it is stated that the cost of coal for a year under electric operation was only 39% that for the last year under steam. The total service charges under electric operation were 60% of the steam and the sum of service and fixed charges was 84.5%. This should represent the operating economy of the new over the old system. It is interesting to note that the cost of electricity, delivered at the locomotive, plus the fixed charges on the generating and distributing system is reported about equal to the cost of coal at the engine under steam operation. The reduction in operating costs comes then, it is claimed, from such items as maintenance and repairs which, for the electric system, was 55% that for steam for the years compared. Each electric locomotive averaged ten round trips per day, or about 2,700 miles per month. To limit the maximum demand on the station, an indicating ammeter is placed in each cab and the enginemen are instructed never to exceed 3,500 amps. on each locomotive unit. If a train will not start on 3,000 amps. the crew is sent to look for troubles in the braking system.

AN ASSOCIATION OF CONTRACTORS, comprising those contractors engaged in work on the New York State Barge Canal, has been organized. According to press accounts the objects of the association are

to oppose such legislation affecting barge canal construction work as is, in the opinion of the association, unwise, properly to discuss and consider work of such magnitude as the construction of this canal affords, and to enable the heads of the various companies to visit the work being done by other companies, and gain ideas as to management and methods.

The association comprises twelve companies holding twenty-two contracts, and other companies holding barge canal contracts are expected to unite. It is positively stated by the officers, and those who have been interested in forming the association, that there will be no attempt to control bidding, and that competition will not be interfered with in any manner. In so large a work, however, there arise many problems in which the contractors might assist each other, they declare, and the association will endeavor to bring this about.

As to legislation, it is said that very often ill-advised legislation is accomplished simply because the facts are not fully known and all sides are not considered. The contractors feel that this work is of such vast magnitude, and has now reached such an advanced stage, that any legislation affecting the canal should be approved with extreme care.

TWO LARGE MASONRY ARCHES should be added to the "List of Masonry Arches Over 175-ft. Span" published in our issue of Sept. 2, 1909, p. 254. These are the

Montangas stone arch of 262 ft. 9½ ins. span across the Valserine in the Department de L'Ain, France, completed last fall, and a reinforced-concrete arch of 328.1 ft. span now in course of construction across the Tiber in Rome, Italy. The first of these bridges is over a rocky gorge some 200 ft. deep and consists of the one segmental arch 262 ft. 9½ ins. long and 65.9 ft. rise, 4 ft. 11 ins. deep at crown and 8 ft. 2½ ins. at spring. Its width is 17 ft. 10½ ins. for the ring and 20 ft. 8 ins. for the roadway, which carries two footpaths, a roadway and a meter-gage railway. The bridge across the Tiber is extremely flat, having only a 32.81 rise for its 328.1-ft. span. It will be the largest masonry arch in the world when completed.

Since publishing the table of arches noted above, we have recorded two other large arches; in our issue of Nov. 25, 1909, p. 584, the recently completed Grafton bridge at Auckland, N. Z., with its 320-ft. reinforced-concrete arch and, in our issue of March 10, 1910, p. 274, the proposed 285-ft. concrete arch to carry the Barge Canal across a gorge at Medina, N. Y.

REMARKABLY RAPID CONCRETE BUILDING construction was executed by the Aberthaw Construction Co., Boston, Mass., in the new reinforced-concrete storage building for the Pierce-Arrow Motor Car Co., at Buffalo, N. Y. This building is four stories high, 308 × 62 ft. in plan, with a 105 × 51-ft. wing, making a total floor space of about 107,500 sq. ft. The contract was placed on Sept. 24, 1909, and the excavation commenced immediately, but there followed about three weeks of very rainy weather during which work was held up, so that building operations did not begin until Oct. 15. The building was ready for occupancy on Jan. 15, 1910, after 72 working days, with no Sunday and very little night work. The building has a reinforced-concrete frame, with the flat-slab system of reinforced-concrete floors, designed for 150 lbs. per sq. ft. live load, and brick curtain walls.

The rapidity of the erection was helped by the compact arrangement of the concrete-handling plant. Except for an emergency pile of sand and gravel, all aggregate was loaded directly from freight cars to barrows in which it was wheeled to the mixer. The cement was unloaded from cars directly to a storage house and taken out on a platform directly opposite the loading platform. These materials were dumped into the mixer, mixed and dumped out into an elevator dump-bucket which carried the concrete to the desired floor, there to be hauled in carts to the proper place. Steel was hoisted into place by a separate derrick. The forms were of a simple design and were used over again in similar places in the building.

A REMARKABLE STEAM SHOVEL RECORD, breaking all records hitherto made on the Panama Canal, was made by Steam Shovel 213 working in the Culebra cut on March 22. According to the "Canal Record" of March 30, this shovel excavated in eight hours' working time 4,823 cu. yds. of rock and earth, measured in place, and loaded 235 Lidgerwood cars. The shovel was actually working five hours and twenty minutes of the time, so the actual average rate of work was 15 cu. yds. per minute. The distribution of time for the eight hours was as follows:

	Minutes.
Time loading	320
Moving up 20 times, 5 minutes each	100
Waiting for cars	55
Coaling shovel	5

The cost for labor for running the shovel on this day was $30.21, and the cost for supplies was $24.59, making a total expense of $54.80, itemized as follows:

Labor.		
1 Engineer, one day, at $7.56	$7.56	
1 Craneman, one day, at $6.48	6.48	
1 Foreman, one day, at $2.83	2.83	
2 Firemen, one day each, at $1.67	3.34	
1 Laborer, 8 hours, at 13 cts.	1.04	
7 Laborers, 8 hours each, at 16 cts.	8.96	
		$30.21
Supplies.		
5¼ tons of coal, at $4.41	$23.15	
3 gallons of car oil, at 18 cts.	.54	
2 gallons of valve oil at 31 cts.	.62	
2 pounds of cup grease, at 10 cts.	.20	
1 pound of gear grease, at 8 cts.	.08	
		24.59
Grand total		*$54.80

*Or 1.14 cts. per cubic yard.

THE SETTLEMENT OF STREETS in Chicago has been noted recently by the daily press, but there appears to be no definite information or record as to the exact original grades. It is a question whether the streets have settled or whether they were ever built to conform to the established grade. The matter has come into prominence due to the reconstruction of the street railway tracks in the business district, the new tracks being at the established grade and considerably above the street level in some places. This has necessitated either a steep slope for the side paving or the practical elimination of gutters. In some cases where sidewalks are apparently below their proper grade the track level or center of street is now higher than the curb. Where curves at street intersections bring the rails close to the curb there is no room for a gutter, and the paving slopes up from the top of curb to the rail, so that all surface drainage flows from the street onto the sidewalk. A rectification of sidewalk grades is proposed by the municipal authorities.

The established grade in the business district is 14 ft. above Chicago city datum (the water level in the river), and this applies to the elevation of the curb. The crown of the old street pavement is in many instances from 8 to 12 ins. below the established grade, but (as noted above) it is considered doubtful whether they were ever built to that grade. Mr. Walter G. Leininger, Assistant Superintendent of Streets, informs us that in reconstructing the street railway lines, the tracks are brought as close as possible to the established grade, and an endeavor is made also to fit the average physical condition of the sidewalks. The present elevation of most of the new tracks is 13.7 above datum.

THE UPPER PART OF A REINFORCED-CONCRETE chimney under construction at the plant of the American Woolen Co., at South Royalston, Mass., collapsed on April 9 causing the death of two workmen, who were in the top of the chimney at the time. The chimney, which was being built by the Weber Chimney Co., of Chicago, was of tapered form, to be 105 ft. high, with an inside diameter of 4 ft. and an outside diameter of 4 ft. 8 ins. at the top, with walls varying from 8 to 4 ins. in thickness from bottom to top. It is reinforced after the type adopted by the Weber Chimney Co., with vertical ¾-in. bars held in place by circumferential ½-in. bars. The forms used in construction were in two sections, each 3½ ft. deep. The procedure in concrete laying was to fill the upper form, then to loosen the lower form and set it above the upper and fill it. This took one day. The next morning the form on the lower section was loosened and it was placed on top and filled, the same procedure being followed in the afternoon for the other form. Thus, the concrete in any 3½-ft. section had about 20 hours to set before the side-supporting forms were removed.

On the day of the accident the chimney had reached a height of about 70 ft. and at 2 p. m. concrete laying was just being started inside a form which had just been moved from a lower to an upper position, when the walls caved in at the section last uncovered, then about 24 hours old, and the upper 8 or 10 ft. of the chimney fell to the ground carrying with it the forms and the two men who were working there.

The contractor reports that the concrete mixture and composition were of the best, the reinforcement was as designed and the method of laying in accordance with good practice. It is reported that the temperature the day before the break had taken a sudden drop, but it was not at any time below freezing. The concrete walls of the chimney will be torn out to a point where their solidity is certain and the construction carried up from that point as designed.

Personals.

Mr. Morgan R. Butler has been recently elected City Engineer of Waukesha, Wis.

Mr. A. S. Robinson, M. West. Soc. E., has been appointed Chief Engineer of the Mountain-Valley & Plains Ry., with headquarters at Dalhart, Tex.

Mr. L. C. L. Smith, M. Am. Soc. C. E., has been dismissed from his position as Engineer in charge of the Queensborough branch of the Department of Water, New York City.

Mr. J. W. Mulhern, Superintendent of the Chicago & Alton Ry. at Bloomington, Ill., has retired. His successor is Mr. P. G. Walton, recently Superintendent of the Southern Ry. at Greensboro, N. C.

Mr. Horace E. Andrews has resigned his position as President of the Cleveland Electric Ry. and will be succeeded by Mr. John J. Stanley, formerly Vice-President and General Manager of the same road.

Mr. T. H. Brannon, formerly Assistant Engineer, Department Public Service, Columbus, Ohio, has been promoted to be Engineer in charge of streets in that city and will be succeeded by Mr. R. C. Chaney.

Mr. H. J. Arrivee has resigned his position as Superintendent of the Houston (Tex.) Water Works and will establish an office for general consultation and waterworks construction work. Mr. John B. Williams has been appointed to succeed Mr. Arrivee.

Mr. H. F. Stimpson, who recently conducted a consulting engineering practice in New York City, with office at 1 Madison Ave., has become Chief Engineer of the Universal Audit Co., 1005 Singer Bldg., New York City, in charge of the design and development of efficiency in industrial plants.

Mr. R. H. Baldwin, locating and construction engineer, 4013 Kenmore Ave., Chicago, who is now with Geo. W. Sturtevant, Consulting Engineer, Chicago, was recently Chief Engineer for the Henry A. Allen Co., Chicago, on a topographical survey of the Jose Lavato Grant (205,000 acres) in New Mexico.

Mr. John B. Gordon, Assoc. M. Am. Soc. C. E., has been appointed Assistant Engineer of the Department of Sewers, Washington, D. C., to succeed Mr. T. C. J. Baily, M. Am. Soc. C. E., who has been made Engineer in charge of street extensions. Mr. Gordon was formerly employed for several years in the sewer department but has been engaged in private practice since 1905. An article by Mr. Gordon on "An Equitable Sliding Scale for Rates of Electric Power" was printed in our issue of April 7.

Mr. John R. Allen, M. Am. Soc. M. E., Professor of Mechanical Engineering at the University of Michigan, has been appointed by the board of trustees of Robert College, Constantinople, Turkey, to make a preliminary study of the proposed schedule of studies for the new school. He will be also Consulting Engineer for the college power house and will consult with the architect engaged by the board as to the requirements of the plans for the buildings. Professor Allen will go to Constantinople this summer to begin this work and will probably go over again the following summer to complete it.

Mr. A. M. Kinsman, Chief Engineer of the Baltimore & Ohio R. R., has relinquished that position and has been appointed Consulting Engineer. On account of ill health, Mr. Kinsman is at present on leave of absence and no particular duties will be assigned to him before his return. Mr. A. W. Thompson, Assoc. M. Am. Soc. C. E., has been appointed to succeed Mr. Kinsman as Chief Engineer. Mr. Thompson was formerly Chief Engineer of Maintenance of Way of the Baltimore & Ohio. He will be succeeded in that position by Mr. Earl Stimson, formerly Chief Engineer of Maintenance of Way of the Baltimore & Ohio Southwestern. Mr. J. B. Carothers, formerly Superintendent of the Illinois division of the latter railroad, has been appointed to succeed Mr. Stimson. Mr. J. Donahue, formerly Trainmaster at Seymour, Ind., will succeed Mr. Carothers as Division Superintendent at Washington, Ind.

Obituary.

Sir Thomas Selby Tancred, a British mining and railway engineer, was found dying in Hyde Park, London, April 11 and his death was described in the coroner's verdict as suicide by prussic acid poisoning. Sir Thomas was 70 years old. Among his principal engineering works was a contract on the Forth Bridge in 1883-89 and the construction of the Delagoa Bay Ry. in Portuguese East Africa in 1887.

The death of Alexander Agassiz, on March 28, was briefly noted in our issue of March 31. The following fine tribute to Mr. Agassiz we take from the "Mining and Scientific Press":

In the death of Alexander Agassiz the world has lost one of its greatest mining engineers. It is not usual to think of him as a mining engineer, for his distinction in the public eye was due more to his achievements in pure science. After all, it is the contributions to knowledge rather than the economic results which a man attains that win applause and lasting honor in the world. This is one of the things that keeps alive our faith in humanity as something more than a mechanism to produce iron and steel and copper or to raise wheat and to irrigate alfalfa. It is a tribute of the highest sort that the scientific and uneconomic achievements of Alexander Agassiz eclipsed his superb success in establishing and guiding the greatest single mining enterprise in the world.

It was due to him that the Calumet & Hecla copper mine in Michigan was placed upon a paying basis; it was his genius that realized the hopelessness of attempting to found a copper industry on the Michigan peninsula based upon enriched spots in the great conglomerate and amygdaloid lodes, but foresaw the possibility of building it up by economical methods of operation on a large scale, utilizing the average low-grade ore. The Calumet & Hecla has distributed to its stockholders $110,550,000 in dividends, making the largest disbursement reached by any mining company in the world, and this from a copper ore that has yielded first and last about 2% of metal.

This splendid success made Mr. Agassiz a multimillionaire, in the clean and noble way of winning fortune from the earth, adding at the same time to the world's wealth. There was never any manipulation of stock nor bleeding of the public. He could show his books and papers to the world and there would be none to reproach him. This wealth, moreover, did not come as sudden riches in answer to a rubbing of Aladdin's lamp.

Mr. Agassiz was born poor; the only son of the intellectual giant Louis Agassiz, who had "no time to make money," being so busy in blazing new paths of knowledge through the unknown. He started in life with no inheritance save a sound training in the best scholarship of the age. He graduated from Harvard in 1855 in his 20th year; in 1859 he began active duty in the West as a surveyor on the Coast Survey in California.

It was in 1865 that he threw himself into the task of developing the Calumet & Hecla. The peninsula was a wild place in those days; inaccessible, and dreary; its vast stretches of swamp had not been reclaimed. There he lived and worked as a pioneer for four years, struggling to win where every one predicted failure, inspiring a handful of friends with confidence while the world laughed at him as a scientific dreamer. But the dream came true, and his supporters were well rewarded.

His distinction as a zoologist and geologist has placed him upon a higher plane than his economic efforts, and in the magnitude of his scientific labors he perhaps excelled those of his father. The difference is that the world is now accustomed to the tenets of progressive evolutionists, so that his contributions carry with them no hint of the iconoclast, and hence are less spectacular. The fruits of his work on the famous Alba-

tross expeditions, however, built higher the structure of zoologic science.

His most notable geologic work consisted in the disproval of the fascinating theory of coral island formation, which Darwin and Dana had worked out like a scientific romance. The world thus lost a pretty conception, but Alexander Agassiz brought us back to truth. No great South Pacific continent had existed and subsided below the waves. With the homely application of the diamond-drill he showed that the accumulations of coral were not due to gradual submergence. His labors for the advancement of knowledge, were conducted at enormous outlay from his private fortune. He will be remembered as a rare man, great as a scholar, scientist, and engineer.

Engineering Societies.

COMING MEETINGS.

AMERICAN WATER WORKS ASSOCIATION.
April 26-30. Annual convention at New Orleans, La. Secy., J. M. Diven, 14 George St., Charleston, S. C.

AMERICAN ELECTROCHEMICAL SOCIETY.
May 5-7. Annual meeting at Pittsburg, Pa. Secy., Jos. W. Richards, South Bethlehem, Pa.

APPALACHIAN ENGINEERING ASSOCIATION.
May 6-7. Annual meeting at Winston-Salem, N. C. Secy., Henry M. Payne, Morgantown, W. Va.

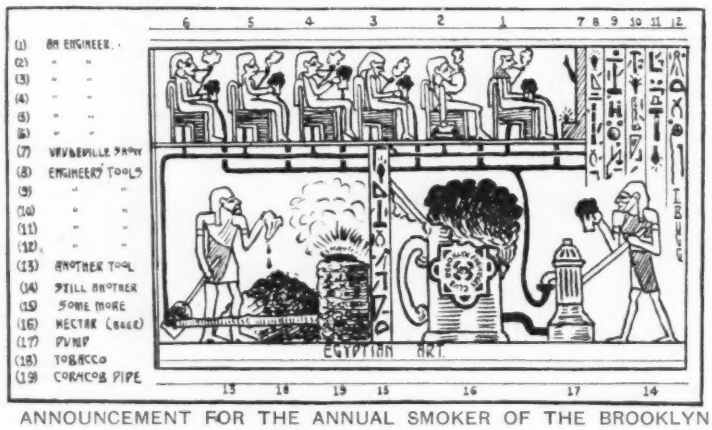
AIR BRAKE ASSOCIATION.
May 10. Annual meeting at Indianapolis, Ind. Secy., F M. Nellis, 53 State St., Boston, Mass.

ASSOCIATION OF RAILWAY TELEGRAPH SUPERINTENDENTS.
May 16-20. Annual meeting at Los Angeles, Cal. Secy., P. W. Drew, Room 306, 135 Adams St., Chicago, Ill.

NATIONAL FIRE PROTECTION ASSOCIATION.
May 17-19. Annual meeting at Chicago, Ill. Secy., Franklin H. Wentworth, 87 Milk St., Boston, Mass.

AMERICAN RAILWAY ASSOCIATION.
May 18. Annual meeting at New York City. Secy., W. F. Allen, 24 Park Pl., New York City.

OHIO SOCIETY OF MECHANICAL, ELECTRICAL AND STEAM ENGINEERS.



ANNOUNCEMENT FOR THE ANNUAL SMOKER OF THE BROOKLYN ENGINEERS' CLUB.

May 19-20. Semi-annual meeting at Cincinnati, Ohio. Secy., F. E. Sanborn, Ohio State University, Columbus, Ohio.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.
May 23-26. Annual meeting at Chicago, Ill. Secy., D. B. Sebastian, 327 La Salle Station, Chicago, Ill.

NATIONAL ELECTRIC LIGHT ASSOCIATION.
May 23-28. Annual meeting at St. Louis, Mo. Secy., T. C. Martin, 29 West 39th St., New York City.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
May 31-June 3. Spring meeting at Atlantic City, N. J. Secy., Calvin W. Rice, 29 West 39th St., New York City.

ENGINEERS' SOCIETY OF PENNSYLVANIA.
June 1-3. Annual convention at Harrisburg, Pa. Secy., E. R. Dasher, Gilbert Bldg., Harrisburg, Pa.

AMERICAN FOUNDRYMEN'S ASSOCIATION.
June 7-9. Annual convention at Detroit, Mich. Secy., Richard Moldenke, Watchung, N. J.

MASTER CAR BUILDERS' ASSOCIATION.
June 15-17. Annual convention at Atlantic City, N. J. Secy., Jos. W. Taylor, 390 Old Colony Bldg., Chicago, Ill.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.
June 20-22. Annual convention at Atlantic City, N. J. Secy., Jos. W. Taylor, 390 Old Colony Bldg., Chicago, Ill.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
June 21-24. Annual convention at Chicago, Ill. Secy., Chas. W. Hunt, 220 West 57th St., New York City.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.
June 22-24. Semi-annual meeting at Niagara Falls, N. Y. Secy., J. C. Olsen, Polytechnic Institute, Brooklyn, N. Y.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.
June 23-25. Annual meeting at Madison, Wis. Secy., Henry H. Norris, Cornell University, Ithaca, N. Y.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
June 27-30. Annual convention at Jefferson, N. H. Secy., R. W. Pope, 33 West 39th St., New York City.

AMERICAN SOCIETY FOR TESTING MATERIALS.
June 28-July 2. Annual meeting at Atlantic City, N. J. Secy., Edgar Marburg, University of Pennsylvania, Philadelphia, Pa.

NEW YORK RAILROAD CLUB.—At the regular meeting April 15 in New York City, Col. B. W. Dunn, Chief Inspector of the Bureau of Explosives, American Railway Association, presented a paper entitled "Stresses Developed by Collisions of Freight Cars."

AMERICAN SUPPLY AND MACHINERY MANUFACTURERS' ASSOCIATION.—The recent convention at Jacksonville, Fla., is to be followed by a convention held conjointly with the National Supply and Machinery Dealers' Association at Atlantic City, N. J., May 11-13.

APPALACHIAN ENGINEERING ASSOCIATION.—Among those who will address the annual meeting at Winston-Salem, N. C., May 6-7, are Dr. Jos. H. Pratt, State Geologist of North Carolina; Mr. W. B. Kilpatrick, of Washington, D. C.; Mr. E. B. Wilson, of Scranton, Pa., and Mr. W. D. Roberts, of Roanoke, Va.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.—The annual meeting is to be held at Madison, Wis., June 23-25. The program will include the reports of the committees on entrance requirements and engineering mathematics. Among the topics of papers to be presented are Technical Education Abroad, Inspection Trips for Technical Students, and Efficiency in Technical Education.

BROOKLYN ENGINEERS' CLUB.—More than 400 members and guests attended the fourth annual smoker held in Brooklyn April 7, and all were enthusiastic over its success. After an opening chorus by the members of the club, a musical program was rendered by a number of soloists and a quartet. The musical program was interspersed with humorous and comic recitations. A clever poster notice announcing the smoker was circulated in the form of blue-prints from the tracing reproduced in the accompanying line cut.

AMERICAN ELECTROCHEMICAL SOCIETY.—Papers and addresses to be presented at the annual meeting in Pittsburg, May 5-7, are announced as follows:

May 5. "Determination of the Constants of Materials for Furnace Electrodes" and "Empirical Laws of Furnace Electrodes," Carl Hering; "On Hering's Alleged Laws of Electrode Losses in Electric Furnaces," C. J. Reed; "A Study in Furnace Conductors for Heavy Alternating Currents," K. C. Randall; "A New Electric Steel Furnace," A. L. Queneau; "On the Presence and Influences of Gases in Steel," P. L. T. Heroult; presidential address on "Science and Industry," L. H. Baekeland; "Possibilities of Cheap Power in the Pittsburg District," F. Crabtree; "Induction Furnace Progress," T. Rowlands; "Ductile Tungsten and Molybdenum," C. G. Fink; "A New Process for the Treating of Cobalt-Nickel Ores Rich in Silver and Arsenic by Combined Melting and Electrolytic Operations," C. C. Cito; "Evolution and Present Status of the Dry Cell," D. L. Ordway; "A New Radiation Pyrometer," C. E. Foster.

May 7. "The Separation of Oil From Condenser Water by Electrolysis," H. M. Goodwin; "A New Method for the Electrolytic and Refining of Metals," E. M. Chance; "An Electrolytic Method for the Reduction of Cassiterite," W. O. Snelling; "Refining Tin Dross in an Electric Furnace," R. S. Wile; "The Conductivity and Electrolysis of Cuprous Chloride Solutions," M. de Kay Thompson; "The Electrolytic Reduction of Nitric Acid," and "Electrolytic Deposition of Platinum," H. E. Patten and W. J. McCaughey; "The Effect of Moisture and of Solutions Upon the Electrical Conductivity of Soils," R. E. O. Davis; "The Electrochemical Potentials of Calcium-Aluminum Alloys," Jas. Breckenridge; "A Rotating Graphite Anode," J. W. Turrentine; "Rapid Electrochemical Methods for the Determination of Copper," F. C. Frary and A. B. Peterson; "The Use of Perchloric Acid in Metal Plating Baths," C. F. Mathers; "The Whiting Electrolytic Cell," Jasper Whiting; "The Townsend Cell: Behavior Under Various Current Densities," H. K. Richardson and R. L. Patterson; "The Present Status of the Electrochemical Industries," J. W. Richards; "Advantages of Pittsburg as an Electrochemical Center," John A. Brashear; "Conservation and Utilization of Natural Sources of Power," John H. Finney.

Mention of the excursions to be made on the afternoon of May 5 and all day May 6 and of other features of the program of entertainments for this meeting was made in our issue of March 31.

WESTERN SOCIETY OF ENGINEERS.—At the meeting on April 6, a lengthy and mathematical paper on "Earth Pressures" was read by Mr. C. K. Mohler. The paper related to the design of abutments and retaining walls, and contained the statement that "the misconception of the middle-third theory and its application has alone been responsible for most of the failures and partial failures of retaining walls and abutments."

The author presented comparisons of results obtained by the formulas of Rankin, Rebhann, etc., showing discrepancies between them. He did not consider that any of these give correct results, and presented a system of his own which was described in full. This he termed the "developed pressure theory, which he based on the assumption that the horizontal pressure is equal to hydrostatic pressure, diminished by the sine of the angle of resistance to flow (or angle of repose) into the hydrostatic pressure."

The presentation of the paper occupied so much time that there was not opportunity for much discussion, but some of the author's ideas and assumptions were disputed. It was suggested that in view of the great development in the use of reinforced-concrete walls some large-scale tests should be made to determine the reliability of results deduced from different formulas.

A paper on "Reinforced-Concrete Trestles for Railways," presented at the meeting on April 13 by Mr. C. H. Cartlidge (C., B. & Q. Ry.), dealt with a class of structures consisting of concrete pile bents, concrete caps and concrete floor slabs. These structures, as developed on the Chicago, Burlington & Quincy Ry. were described and illustrated in our issue of May 20, 1909.

The author stated that this class of structure was designed to meet conditions where (as in the Mississippi valley especially) railways traverse river bottoms and swamps by low-level pile trestles which may not be filled and the replacement of which by steel structures would be extremely expensive on account of their great length. One reason for the low cost of wooden pile trestles on bridges of the class noted is the small amount of work to be done in the field. There are no cofferdams, foundation pits or falseworks to be built, while very little material has to be unloaded and cared for. In designing a permanent structure to meet the conditions, these features were borne in mind. Several of these concrete pile trestles, 80 ft. to 250 ft. long, have been built at a cost varying from $20 to $26 per lin. ft., while in a few short bridges of two or three spans only, the cost has been as high as $45. For the purpose of estimating, a cost of $30 per ft., plus a constant of $300, is considered ample.

AMERICAN SOCIETY OF CIVIL ENGINEERS.—At the meeting in New York City April 20, a paper was presented for discussion entitled "Federal Investigations of Mine Accidents, Structural Materials and Fuels at the U. S. Testing Station, Pittsburg, Pa.," by Herbert M. Wilson, of the U. S. Geological Survey. This paper was published in the February "Proceedings."

NEW ENGLAND WATER WORKS ASSOCIATION.—A special meeting was held at the Allyn House, Hartford, Conn., on Wednesday, April 13. About 115 members and guests were present, an attendance fully up to the average of the regular meetings in Boston. President King announced that the date of the annual convention, which is to be held in Rochester, N. Y., has been changed from Sept. 14-16 to Sept. 21-23.

The meeting was opened with a general discussion upon cleaning water mains. Mr. E. C. Brooks, Superintendent of Water Works at Cambridge, Mass., described his experience with the cleaning of a short piece of 6-in. pipe, out of which a great deal of material was taken, and the capacity of which was materially increased by the cleaning. A few other members cited their own experiences, or cases of which they knew, telling of the amount of cleaning accomplished and the resulting improvement in the carrying capacity of the pipe. Mr. Allen Hazen stated that in some cases of which he had knowledge, the cleaning not only removed the deposits and tubercles but also a considerable amount of the pipe coating, with the result that thereafter there was a good deal of trouble from red water, with the probability that the growth of tubercles would be much more rapid in the future.

The question of secondary water supplies, relating especially to secondary fire supplies, separated from the public supply by check valves or other means, was introduced by Mr. E. E. Lochridge, Chief Engineer of the Springfield Water Works, and many members took part in the discussion. It seemed to be the general opinion that the ordinary check valve was likely to prove of little or no value in preventing the admission of impure water from such supplies into the main pipes. Some members described improved check valves which have proved much more satisfactory, and other arrangements for separating or in some cases completely divorcing secondary supplies from the public water supply were described in considerable detail.

Mr. L. W. Goodrich, Forester of the Hartford Water Dept., presented a paper on forestry, and was followed by Prof. Hawley, of the Yale Forestry School, who made an earnest plea for the utilization of lands belonging to water departments for tree planting, or as he termed it, "utilization of the by-products of the water department." Several others took part in the discussion which followed.

It seemed to be the common opinion of those present that the meeting was an excellent one and that, as far as could be judged from the one trial, the experiment of holding a meeting similar to the regular winter meetings but at a point somewhat distant from Boston was a decided success.—Charles W. Sherman.